Deloro Mine Site Cleanup
Young's Creek Area Closure Plan
Final Report

Prepared for:

ONTARIO MINISTRY OF THE ENVIRONMENT

Prepared by:

CH2MHILL

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Executive Summary

The Deloro Mine/Refinery Site, located in Eastern Ontario, began operation as a gold mine in the 1860s. Over the next 100 years, site activities also included the smelting and refining of a number of other metals including arsenic, silver, and cobalt. Activities associated with the mining, smelting and refining of metals ceased in the 1950s. These historical activities at the site have resulted in significant environmental impacts to the soil, groundwater, surface water, and sediment quality both onsite and offsite.

Abandonment of the site by its owner(s) forced the Ontario Ministry of the Environment (MOE) to take control of the property in 1979 and to initiate control measures to limit the environmental impact from the site. Remedial initiatives by the MOE have resulted in reductions of arsenic loadings to the Moira River. Arsenic loading to the Moira River has been reduced by more than 80 percent from an annual average of 52.1 kg/day in 1979 to an annual average of less than 10 kg/day since 1983.

To provide further treatment, and to mitigate any unacceptable impacts on human health and the environment, CH2M HILL Canada Limited (CH2M HILL; formerly CH2M Gore & Storrie Limited [CG&S]) was retained by the MOE to develop and implement a comprehensive rehabilitation program focussing on four individual areas of concern at the Deloro Mine Site. These areas included the Mine Area, the Industrial Area, the Tailings Area, and the Young's Creek Area. Subsequently a detailed evaluation of rehabilitation alternatives was conducted by CH2M HILL in 2002/2003 separately for each of these four areas, which resulted in a rehabilitation alternative being recommended for each area of the site. CH2M HILL then further developed the recommended rehabilitation alternative by completing a separate Closure Plan for each area of the site. This report serves as the Closure Plan for the Young's Creek Area of the site.

Young's Creek is located along the east part of the Deloro Mine Site and consists of an onsite and an offsite portion. The sediment in the onsite portion of the Young's Creek Area (south of the east tailings dam and north of Highway 7) are contaminated to varying degrees with arsenic, cobalt, copper, nickel compounds, as well as low-level radioactivity. The contamination is widespread within the upper 0.5-m of the red mud and organic sediment of the flood basin. The contamination extends deeper into the silty-clay layer in the northern half of this area. The sediment in the offsite portion of the Young's Creek Area (south of Highway 7 extending to the confluence with the Moira River), are also contaminated with arsenic and metals, albeit to a significantly less degree, than the onsite sediment. Contamination in the offsite sediment is limited generally to the upper 0.5 m. The underlying silty-clay offsite sediment quality is comparable to that found in the Moira River watershed.

The source of sediment contamination both onsite and offsite has likely been the occasional historical releases and seepage from the Tailings Area impoundment. The contaminated sediment exceed the MOE's Severe Effect Level (SEL), which means there is potential for harmful impacts to the local aquatic and terrestrial ecosystems. A further hazard to human health is posed by the potential for re-mobilization of the contaminated sediment during flooding events, which will result in high contaminant loadings to the Moira River. In addition, the low-level radioactivity in the onsite portion of the Young's Creek Area may

pose a human health or ecological hazard both as it exists in place as well as via suspended particulate from dried radioactive sediment.

CH2M HILL completed an evaluation of rehabilitation alternatives for the Young's Creek Area in May 2003 (CH2M HILL, May 2003). The comprehensive remediation alternatives that were evaluated included:

- Shallow Excavation, Disposal Onsite, Creek Rehabilitation with optional enhancing features:
  - In-Place Capping
  - Flow Regulation
- Deep Excavation, Disposal Onsite, Creek Rehabilitation

These comprehensive remediation alternatives were evaluated using detailed evaluation criteria that considered technical, cost, natural environment, and social factors. The onsite and offsite portions of the Young's Creek Area were evaluated separately due to significant differences in the onsite and offsite portions of Young's Creek (i.e. water depth, contaminant level, property ownership). The detailed evaluation resulted in the following comprehensive remediation alternative being recommended for the Young's Creek Area:

- Deep Excavation, Disposal Onsite, Creek Rehabilitation (Onsite Portion of Young's Creek)
- Shallow Excavation, Disposal Onsite, Creek Rehabilitation (Offsite Portion of Young's Creek)

This Closure Plan further develops and refines the above recommended alternative for the Young's Creek Area and provides the following information:

- A detailed description of the rehabilitation activities
- An implementation plan and schedule
- Anticipated construction impacts and mitigation measures
- A cost opinion
- A health hazard assessment
- An environmental and community health protection plan
- Operation and maintenance efforts
- Recommended short and long-term monitoring requirements
- Probable malfunctions and accidents and corresponding mitigation measures
- The expected post-closure conditions and uses of the site
- Known and anticipated approval requirements

The recommended alternative consists of the construction of a secure engineered onsite containment cell to store the wastes. Approximately 267,000 m^3 of contaminated sediment and soil will require excavation and onsite disposal under this alternative. Sediment/soil quality, following excavation, will be similar to the ambient sediment quality in the Moira River, Moira Lake, and Stoco Lake. Following excavation of the contaminated sediment and soil, creek rehabilitation measures will be implemented that include construction of a perimeter wetland shelf and the installation of two strategically located wetland parcels.

Rehabilitation efforts in the Young's Creek Area have been divided into five distinct work packages. The work packages listed below have been assembled such that each work package could be contracted out and constructed independently of the other work packages, if desired.

- YC-WP#1 Containment Cell Liner System Construction: Phases 1 and 2
- YC-WP#2 Onsite Contaminated Sediment and Soil Excavation, Dewatering, and Placement in Containment Cell
- YC-WP#3 Onsite Creek Rehabilitation
- YC-WP#4 Offsite Contaminated Sediment Excavation, Dewatering, and Placement in Containment Cell
- YC-WP#5 Offsite Creek Rehabilitation

In general, the work packages would be completed in the order listed above. It is estimated that the amount of time required to rehabilitate the Young's Creek Area would be approximately four years.

Anticipated construction impacts are identified in the Closure Plan and include the following:

i) Disruption During Fish Spawning Periods
ii) Suspended Sediment in Surface Water
iii) Suspended Particulates in Air
iv) Removal of Vegetation to Create Temporary Access Roads
v) Removal of Vegetation and Rock Blasting to Prepare Site for Containment Cell

Mitigation measures to address each of these anticipated impacts are described in the Closure Plan.

The total estimated cost to clean up and rehabilitate the Young's Creek Area (Onsite and Offsite portions) is $16,873,000 in 2004 dollars with average weighted annual operation, maintenance, and monitoring (OMM) costs of $41,508. The net present value (NPV) of this remediation work, assuming an effective interest rate of 5 percent and a planning horizon of 20 years, is $17,538,000. The capital costs presented in this Closure Plan include GST, a 15 percent contingency, and the cost of various construction bonds associated with the work. The costs presented are expected to have an accuracy on the order of +/-25 percent. A breakdown of the estimated costs and the major assumptions used in making this cost estimate are provided in Appendix A of this report. The costing in Appendix A has been completed at the preliminary design level and should be considered as a "cost opinion" to assist in budgeting. An appropriate allowance should be included in any budget planning to account for cost escalation above 2004 dollars. Costs can further be refined, once the recommended alternative has been accepted and a detailed design and approach has been finalized.

A health hazard assessment for the site has been previously documented in a report entitled *Deloro Mine Rehabilitation Project – General Health and Safety Plan (GHASP), Final Report* (CH2M HILL, January 2002). The GHASP, which was updated in April 2003, identifies the following health hazards associated with the Deloro Mine Site, that could be encountered while undertaking site inspections, site investigations, and remedial cleanup:

- Arsenic and arsenic compounds, other metals and silica
- Radiological hazards

- Heat and cold stress
- Buried utilities
- General physical (safety) hazards
- Biological hazards
- Chemicals existing at or brought onto site

The GHASP outlines and describes appropriate procedures and protocols to effectively deal with the above hazards associated with the Deloro Mine Site. The GHASP addresses: hazard evaluation and control procedures and protocols (including action levels), personal protective equipment to be used, air monitoring protocols and specifications, decontamination procedures and protocols, spill containment procedures, confined space entry procedures, emergency response plan, and emergency contacts.

An Environmental and Community Health Protection Plan (ECHPP) is detailed in this Closure Plan. In specific, the ECHPP details dust control measures, air monitoring requirements, noise control measures, methods to protect surface water quality, decontamination procedures, and precautions to be used during the transport of contaminated sediment across Highway 7.

Operation and maintenance requirements associated with the rehabilitation of the Young's Creek Area include the repair of erosion damage to the cap of the secure containment cell, replanting of dead plant material in the constructed wetland parcels and perimeter wetland shelf, and occasional pumping of leachate from the leachate holding tank for transportation to the onsite treatment plant. A monitoring program is also outlined in the Closure Plan and includes monitoring of:

- Physical stability of the secure containment cell
- Surface water quality during the construction phase and beyond
- Leachate quality
- Sediment/soil quality immediately after excavation (confirmatory monitoring)
- Biomonitoring

The Closure Plan identifies potential malfunctions (i.e. in design, construction, or commissioning) and accidents (i.e. due to acts of nature) that could feasibly occur during the construction and operation of the rehabilitative measures at the site. Mitigation measures are specified for each potential malfunction or accident that has a reasonable probability of occurrence.

With regard to the expected post-closure conditions and land use conditions, the onsite portion of the Young's Creek Area will continue to be restricted to the public. A chain link fence will remain along the perimeter of the site and signage will be posted to prevent public access and use. The onsite portion of the Young's Creek Basin will be submerged year round due to the depth of excavation required. Land uses and post-closure conditions for the offsite portion of the Young's Creek Basin will be similar to current conditions. The offsite portion of Young's Creek is privately owned, although public access to this land is possible. Potential uses of the offsite portion of Young's Creek include recreational activities such as fishing and canoeing.

The topography of both the onsite and offsite portions of the Young's Creek Basin will be similar to existing pre-remediation conditions. The primary change in topography that will

occur as a result of post-closure activities will be the secure onsite containment cell. Public visual impacts associated with the containment cell will be improved as the area is cleaned up and restored, and any negative impacts are anticipated to be very minimal. Limited public visibility of the containment cell will exist at two locations, the Village of Deloro, and the Highway 7 bridge over Young's Creek. The top elevation of the containment cell (205 masl) will be similar to the ground elevation in the Village of Deloro. Considering the tree cover between the Village and the proposed containment cell, visual impacts to Deloro residents will be minimal. The elevated islands existing between the Highway 7 bridge and the proposed containment cell will act to block out much, if not all of the containment cell to traffic on Highway 7.

The regulatory approval requirements associated with the Deloro Mine Site Cleanup Project are outlined in this Closure Plan. These approval requirements will involve the following local, provincial, and federal agencies: the Moira River Conservation Authority (MRCA) care of Quinte Conservation (QC), Ministry of the Environment (MOE), Ministry of Natural Resources (MNR), Department of Fisheries and Oceans (DFO), Canadian Coast Guard (CCG), and Canadian Nuclear Safety Commission (CNSC).

Even though the Crown (i.e. the Provincial Government) is exempt from the requirements of the *Mining Act*, the Closure Plans have been developed to satisfy in general the requirements of the document entitled *Rehabilitation of Mines, Guidelines for Proponents* (MNDM, 1995). The latter document includes provisions for protection of the environment. MNDM has agreed to review the Closure Plans relative to accepted standards for closure and rehabilitation of mines in Ontario, although a specific approval will not be issued.

This Closure Plan will be the subject of additional public consultation and stakeholder review in addition to providing supporting documentation for regulatory reviews and applications. **It is anticipated that the Closure Plans may need to be revised, as a result of the public consultation and stakeholder review and to incorporate the findings of ongoing studies such as the Site-Specific Risk Assessment and groundwater modelling studies. Revisions are expected to refine the recommended alternative for each main area of the site but not result in a fundamental change in direction.** The comments and additional findings will be incorporated into the final rehabilitation strategy and implemented in the construction phase of the project.

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List of Acronyms

AAQC	Ambient Air Quality Criteria
ATP	Arsenic Treatment Plant
C of A	Certificate of Approval
CCG	Canadian Coast Guard
CEAA	Canadian Environmental Assessment Act
CNSC	Canadian Nuclear Safety Commission
COC	Chemical of Concern
DFO	Department of Fisheries and Oceans
EA	Environmental Assessment
EAA	Environmental Assessment Act
ECHPP	Environmental and Community Health Protection Plan
EIS	Environmental Impact Study
EPA	Environmental Protection Act
FA	Federal Authority
GHASP	General Health and Safety Plan
GST	Goods and Services Tax
GUCSO	Guideline for Use at Contaminated Sites in Ontario
HADD	Harmful Alteration, Disruption, or Destruction
HDPE	High-Density Polyethylene
HHRA	Human Health Risk Assessment
HQ	Hazard Quotient
LLRW	Low-Level Radioactive Waste
masl	Metres Above Sea Level
MNDM	Ministry of Northern Development and Mines
MNR	Ministry of Natural Resources
MOE	Ministry of the Environment
MOEE	Ministry of Environment and Energy
MRCA	Moira River Conservation Authority
NSCA	Nuclear Safety and Control Act
NPV	Net Present Value
NWPA	Navigable Waters Protection Act
OCWA	Ontario Clean Water Agency
ODWS	Ontario Drinking Water Standards
OWRA	Ontario Water Resources Act
OMM	Operation, Maintenance, and Monitoring
PC of A	Provisional Certificate of Approval
PSW	Provincially Significant Wetland
PTTW	Permit to Take Water
PWQO	Provincial Water Quality Objectives
QC	Quinte Conservation
RA	Responsible Authority
RSC	Record of Site Condition

SDB	Standards Development Branch
SEL	Severe Effect Level
SLERA	Screening Level Ecological Risk Assessment
SSRA	Site-Specific Risk Assessment
TERP	Transportation and Emergency Response Plan
TOR	Typical Ontario Resident
TSP	Total Suspended Particulate
VEC	Valued Ecosystem Component
VSC	Valued Social Component
WNSL	Waste Nuclear Substance License

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1. Introduction

1.1 Background

1.1.1 Deloro Mine Site

The Deloro site is located in Eastern Ontario along the banks of the Moira River (Figure 1-1) east of the Village of Deloro (Figure 1-2). The former refinery/smelter site (Industrial Area) is approximately 25 ha in area and is located adjacent to the west bank of the Moira River. The Tailings Area is located east of the Industrial Area between the east side of the Moira River and the west side of Young's Creek. The entire property, which includes the Industrial Area, Tailings Area, Mine Area, and the onsite portion of Young's Creek, is approximately 202 ha in area (CH2M HILL, February 2002).

Access to the mine site is via Deloro Road, which is accessed from Highway 7, approximately 4 km east of Marmora. The principal population centres in the area are the Village of Deloro (pop. 180), and the Villages of Marmora (pop. 1,700) and Madoc (pop. 1,400), located approximately 5 km southwest and 10 km east of the mine site, respectively.

The Deloro site began operation as a gold mine in the 1860s and evolved over the next century to mine and refine gold, as well as smelting and refining of a number of other elements including arsenic, silver, and cobalt. It was the first plant in the world to produce cobalt commercially and was also a leading producer of stellite, a cobalt-chromium-tungsten alloy. Concentrates from uranium extraction were imported to the site and further processed to extract cobalt. Arsenic-based pesticides were produced from the by-products of smelting operations and continued as a main activity at the site until the market collapsed in the late 1950s.

A century of handling hazardous materials and chemicals has resulted in significant environmental degradation of the Deloro Mine Site. Large quantities of refining slag, mine tailings, calcium arsenate, and arsenical pesticides remained at the site. Fuels, chemicals, and raw materials, such as sulphuric acid, coke, lime, soda ash, caustic soda, liquid chlorine, salt, scrap iron, sodium chlorate, and fuel oil were handled at the site. Radioactive slag and tailings were produced as a result of the re-refining of by-products from uranium refining.

The Ontario government stepped in to take control of the site in 1979 due to failure of the owner to control environmental releases. The Ministry of the Environment (MOE) has been in care and control of the site since that time. Several rehabilitation actions have been implemented at the site that have significantly reduced releases from the site. In 1979, the annual average loading of arsenic to the Moira River was 52.1 kg/day. Since the Arsenic Treatment Plant (ATP) located in the Industrial Area of the site was put into operation in 1983, the arsenic loading to the river has been reduced by more than 80 percent, to an annual average of less than 10 kg/day. However, further work is required to reduce releases to acceptable levels and to secure the site for the long term. CH2M HILL Canada Limited (CH2M HILL) was retained to provide consulting engineering and project management services for the Deloro Mine Site Cleanup.

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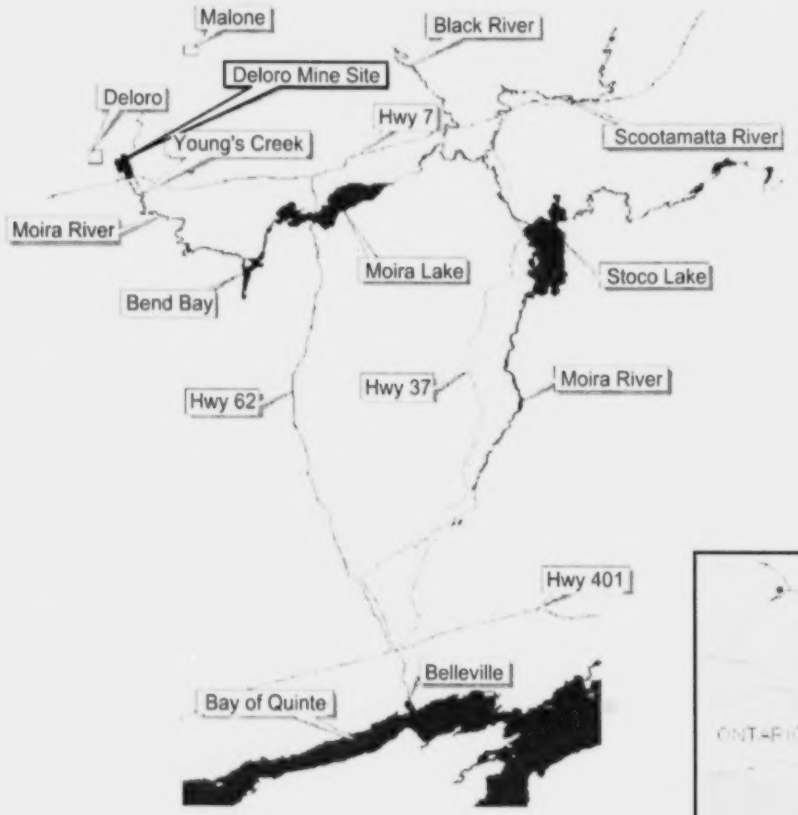

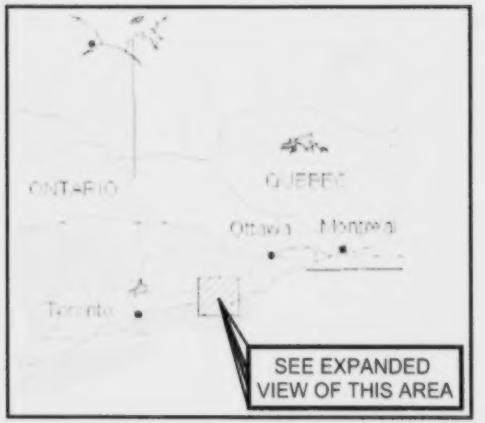

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DELORO MINE SITE CLEANUP

FIGURE 1-1
SITE LOCATION PLAN

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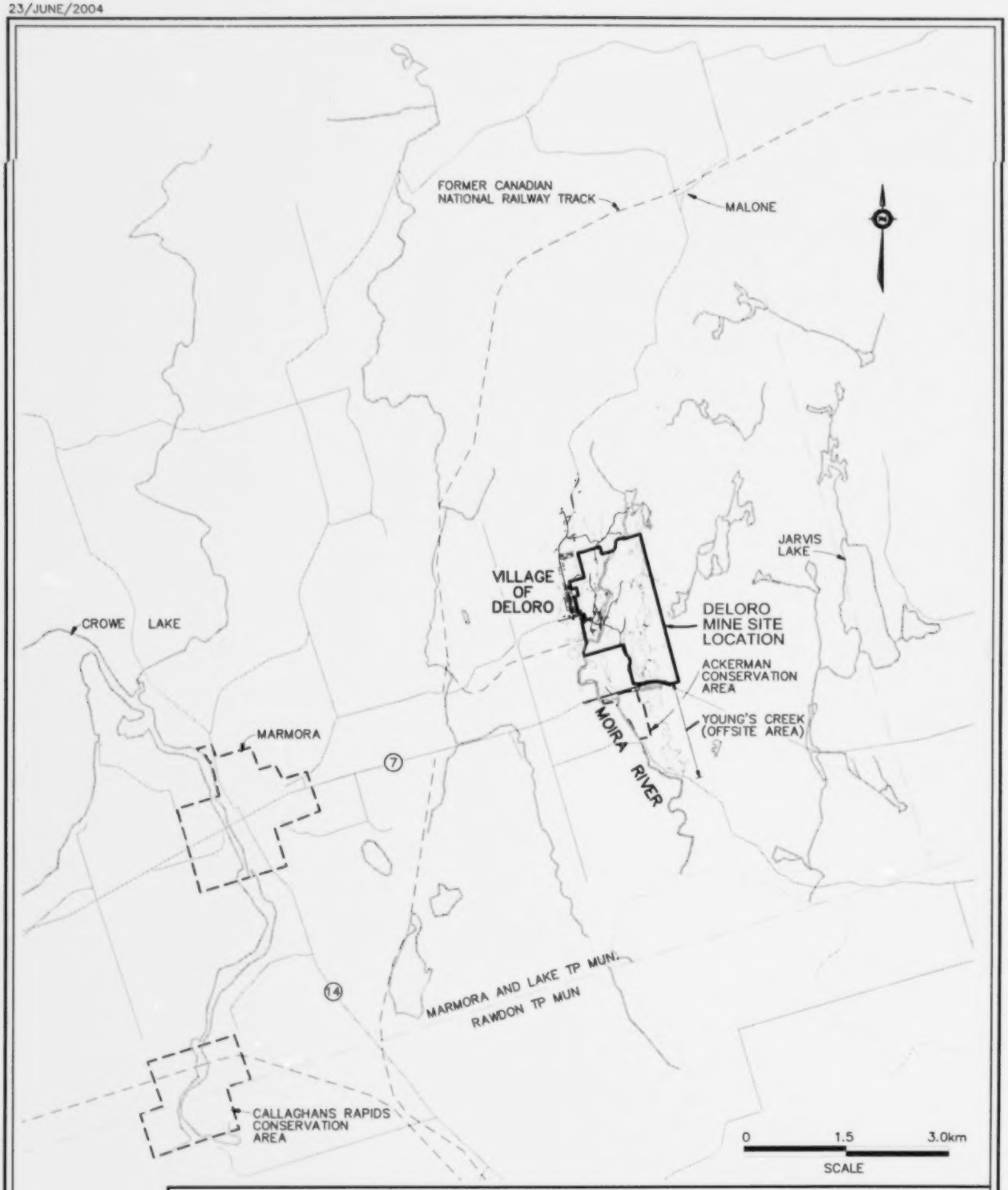

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DELORO MINE SITE CLEANUP

FIGURE 1-2
DELORO MINE SITE LOCATION

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1.1.2 Rehabilitation Alternatives

CH2M HILL was retained by the MOE to develop and implement a comprehensive rehabilitation program for the closure of this former mine site. As part of this comprehensive rehabilitation program, CH2M HILL evaluated a broad range of rehabilitation alternatives and identified a recommended alternative for further development for each of the four areas within the mine site's footprint, as shown in Figure 1-3. The limits of these four areas have been developed based on historical land use and waste disposal practices. The four areas are:

- The Industrial Area, where smelting and refining of the various ores were carried out
- The Tailings Area, where the by-products of the production phase were stored
- The Mine Areas, on both the east and west sides of the Moira River
- The Young's Creek Area, which has been impacted from historical releases from the Tailings Area

The rehabilitation alternatives reports prepared by CH2M HILL are as follows:

- *Deloro Mine Site Cleanup – Industrial Area Rehabilitation Alternatives* (December 2003)
- *Deloro Mine Site Cleanup – Tailings Area Rehabilitation Alternatives* (October 2003)
- *Deloro Mine Site Cleanup – Mine Area Rehabilitation Alternatives* (October 2003)
- *Deloro Mine Site Cleanup – Young's Creek Area Rehabilitation Alternatives* (May 2003)

1.1.3 Purpose of this Closure Plan

The overall objective of the Deloro Mine Site Cleanup is to successfully rehabilitate the mine site to mitigate, within reason, any unacceptable impacts on human health or the environment. As part of this overall objective, several area-specific objectives have been developed. Achieving these objectives, in conjunction with the other area-specific objectives, will aid in the successful rehabilitation of the Deloro Mine Site.

The Closure Plans for each of the four areas of the site are based on the site-wide closure objectives identified in the report entitled *Deloro Mine Rehabilitation Project – Development of Closure Criteria, Final Report* (CG&S, October 1998), including area-specific closure objectives (see Section 1.3), and the recommended rehabilitation alternatives developed for each area. The recommended alternatives are further developed in the four Closure Plans as follows:

- *Deloro Mine Site Cleanup – Industrial Area Draft Closure Plan*
- *Deloro Mine Site Cleanup – Tailings Area Draft Closure Plan*
- *Deloro Mine Site Cleanup – Mine Area Draft Closure Plan*
- *Deloro Mine Site Cleanup – Young's Creek Area Draft Closure Plan*

Even though the Crown (i.e. the Provincial Government) is exempt from the requirements of the *Mining Act*, the closure plans have been developed to satisfy in general the requirements of the document entitled *Rehabilitation of Mines, Guidelines for Proponents* (MNDM, 1995). The latter document includes provisions for protection of the environment.

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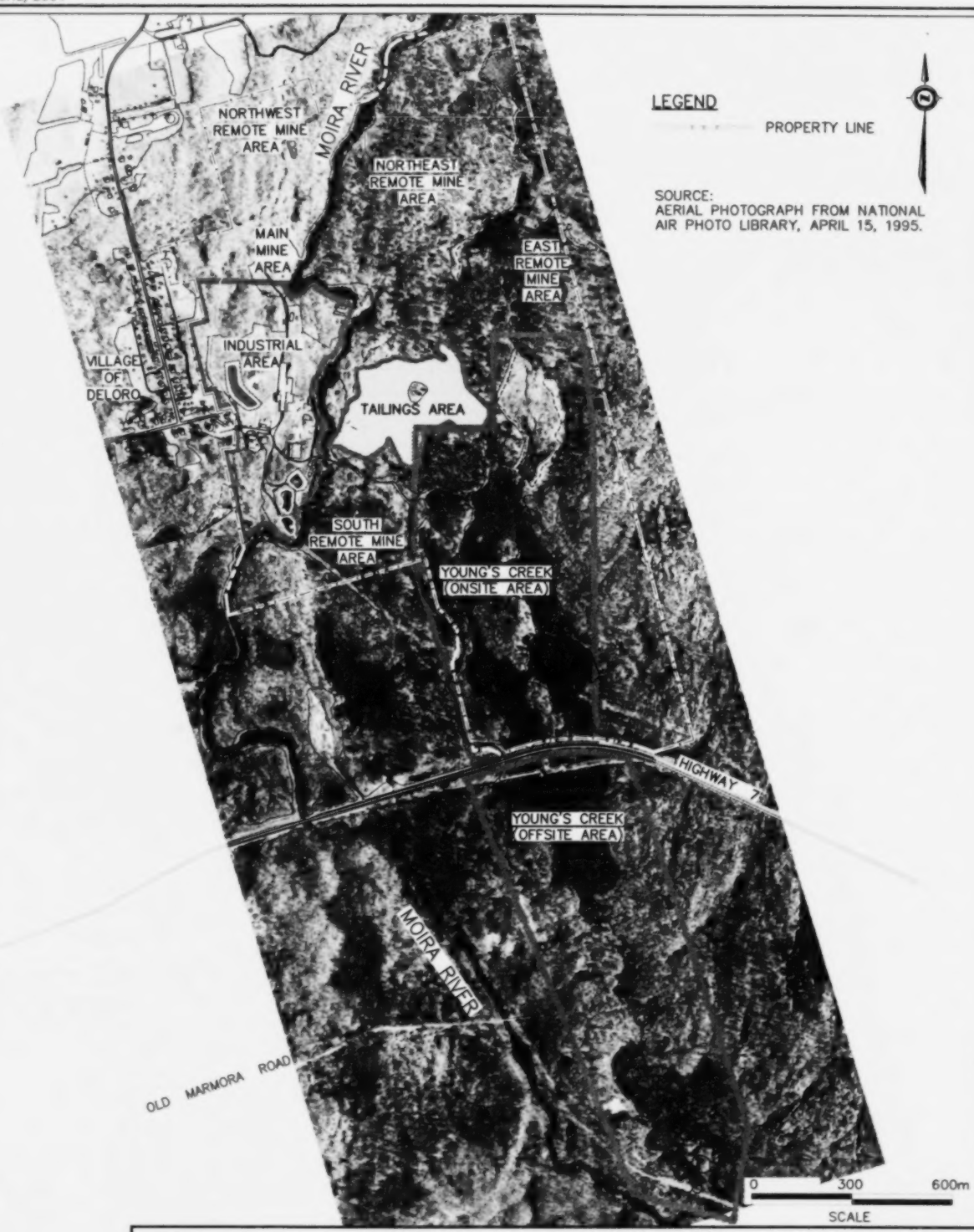

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DELORO MINE SITE CLEANUP

FIGURE 1-3: DELORO MINE/REFINERY SITE SHOWING THE INDUSTRIAL, MINE, TAILINGS AND YOUNG'S CREEK AREAS - DELORO, ONTARIO

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The Closure Plans will be the subject of additional public consultation and stakeholder review in addition to providing supporting documentation for regulatory reviews and applications. **It is anticipated that the Closure Plans may need to be revised, as a result of the public consultation and stakeholder review and to incorporate the findings of ongoing studies such as the Site-Specific Risk Assessment and groundwater modelling studies (see Section 2). Revisions are expected to refine the recommended alternative for each main area of the site but not result in a fundamental change in direction.** The comments and additional findings will be incorporated into the final rehabilitation strategy and implemented in the construction phase of the project.

An integrated technical cleanup plan will be prepared to present a summary of the four Closure Plans and to optimize and prioritize the remedial actions.

1.1.4 Organization of Report

This report consists of ten sections, including the introduction. Section 2 summarizes the findings of other technical studies undertaken to support the closure plans. A detailed description of the recommended alternative for the Young's Creek Area is presented in Section 3 including site security and safety, building demolition, waste removal and handling, waste isolation and containment, water management, mine workings, crown pillars and surface workings, final site grading, and site rehabilitation and revegetation. Section 4 presents an implementation plan for the selected alternative including identification and sequencing of work packages, identification of anticipated construction impacts and mitigation measures, an implementation schedule, a cost opinion, a health hazard assessment, an environmental and community health protection plan, and other operational procedures. Section 5 describes operation and maintenance efforts outlined under the recommended remedial alternative. A recommended monitoring program is discussed in Section 6, focusing on physical monitoring, chemical stability and water quality, biomonitoring and site management. Potential malfunctions and accidents and corresponding mitigation measures are examined in Section 7. Section 8 details the expected post-closure conditions and uses of the site. Known and anticipated approval requirements are outlined in Section 9, and Section 10 lists the references used in the preparation of this report. The detailed cost opinion is provided in Appendix A.

1.2 Related Reports and Studies

A list of reports and other documents referenced in this document is provided in Section 10. Related reports and studies are on public record and available for review from the Kingston MOE office. Of particular interest to the reader will be the document titled *Deloro Mine Site Cleanup – Young's Creek Area Rehabilitation Alternatives, Final Report* (CH2M HILL, May 2003). The report presents details of a range of alternatives for cleanup of the Young's Creek Area.[1] The alternatives that were considered are summarized in Section 1.4 below.

[1] The Young's Creek Rehabilitation Alternatives report also includes information and discussion pertinent to "Current Environmental Conditions" and "Project Description" as defined by MNDM, 1995.

1.3 Cleanup Approach and Criteria

Extensive previous investigation and evaluation has been undertaken at the Deloro Mine Site. Based on strategic decisions made by the MOE in the early 1990s, the most viable solutions for management of residuals at the Deloro Mine Site involve onsite management through isolation and containment techniques. An approach that includes cleanup to "natural background" is prohibitively costly and is not considered to be the most prudent expenditure of public funds. Instead, a more pragmatic approach has been adopted in which mitigative action is directed at risk reduction. In this approach, risks to both human health and the environment are considered under both the current and reasonably expected future land uses. This approach has been recognized as an option in the MOE's *Guideline for Use at Contaminated Sites in Ontario* (MOE, 1997), in which it is referred to as the Site-Specific Risk Assessment (SSRA). The SSRA is the approach selected by the MOE as proponent for the Deloro site rehabilitation.

The strategic direction for site cleanup, involving the onsite management of wastes through isolation and containment methods as primary remediation techniques, is described in the report entitled *Deloro Mine Rehabilitation Project - Development of Closure Criteria, Final Report* (CG&S, October 1998). This translates into the following project objective:

> *To successfully rehabilitate the Deloro Mine Site to mitigate any unacceptable impacts on human health or the environment in compliance with relevant environmental policies and regulations.*

To satisfy this objective, specific site-wide and distinct area closure objectives were developed. The site-wide closure objectives are as follows:

1. Reducing the loading of arsenic and other contaminants to the Moira River
2. Compliance with appropriate regulations and policy
3. Satisfying the general intent of the *Mining Act* and related draft regulations
4. Reducing/controlling impact/risk to acceptable levels
5. Demolition of unneeded buildings to ground level
6. Prioritizing remedial action implementation according to risk reduction
7. Minimizing perpetual operation and maintenance
8. Restoration of the site to reflect its natural surroundings
9. Securing the site for the indefinite future
10. Managing the wastes over the smallest possible area

The overall closure objective is intended to achieve a 90 percent reduction in arsenic discharge to the Moira River to achieve Provincial Water Quality Objectives (PWQO) at the intersection of the Moira River and Highway 7, as described in the document entitled *Deloro Mine Rehabilitation Project – Development of Closure Criteria, Final Report* (CG&S, October 1998). Monitoring will be performed to assess actual performance. Contingency measures have been incorporated as part of the recommended alternative for each area of the site and are further developed as part of the Closure Plans.

These site-wide closure objectives were further refined into area-specific closure objectives for each area of the site. Specific closure objectives for the Young's Creek Area are stated below. These objectives are consistent with the specific objectives developed for the other

areas of the site, specifically the upstream Tailings Area. Closure objectives specific to the Young's Creek Area include:

1. Develop a rehabilitation Closure Plan supported by a Site-Specific Risk Assessment (SSRA)
2. Develop/implement risk reduction plans according to site-wide priorities
3. Implement measures to reduce potential exposure of contaminated sediment to human and environmental receptors
4. Implement measures to prevent increased contaminant loading to the Moira River due to re-suspension of residual contaminated material
5. Restore area to match surrounding conditions and in accordance with Ministry of Natural Resources (MNR) policies and requirements
6. Design life for engineered facilities consistent with accepted design practices

1.4 Alternatives Considered

As previously noted, the Deloro Mine Site cleanup is being conducted according to the *Guideline for Use at Contaminated Sites in Ontario* (GUCSO), (MOE, 1997) following the SSRA option. The approach has been adapted or enhanced to meet other regulatory or best management practices including the *Canadian Environmental Assessment Act* (CEAA).

A process was developed to generate potential remedial alternatives and select a recommended alternative for all areas of the Deloro site. This process is described in the Alternatives report *Deloro Mine Site Cleanup – Young's Creek Area Rehabilitation Alternatives, Final Report* (CH2M HILL, May 2003). Initially, conceptual remediation methods that could have addressed some or all of the issues identified for each respective area of the site were identified. For instance, a method may address groundwater issues but not impacted sediment. These methods were evaluated with a screening process to identify which methods had the greatest potential to address the issues at the site, either alone or in combination with other methods. Improbable methods that did not have significant potential to contribute to a viable solution were eliminated early in the process. This resulted in a list of primary remediation methods that were retained for further evaluation.

The primary remediation methods were combined with enhancing features, based on the judgement and experience of the project team, to create a number of comprehensive remediation alternatives that addressed all of the environmental issues at the site. These comprehensive remediation alternatives were subsequently evaluated in a two-step process. The screening level evaluation again served to eliminate comprehensive remediation alternatives (as opposed to conceptual remediation methods that had been previously screened) that were unlikely to meet all of the remediation needs for the area. This second level of screening led to a short list of comprehensive remediation alternatives that were the subject of a more detailed evaluation. The detailed evaluation led to the identification of a recommended remediation alternative, which would be developed further and subsequently implemented to address the environmental issues at the site.

The remediation methods considered for the Young's Creek Area include:

- Shallow Excavation of Highly Contaminated Sediment and Disposal Onsite
- Shallow Excavation of Highly Contaminated Sediment and Onsite Treatment
- Deep Excavation of Highly Contaminated Sediment and Underlying Contaminated Silty Clay Soil and Disposal Onsite
- In-Place Capping of Contaminated Sediment
- Creek Rehabilitation
- Flow Diversion Away from Most Highly Contaminated Sediment
- Flow Regulation in the Contaminated Portion of the Young's Creek Area

It was realized that none of the methods alone could address all of the issues associated with Young's Creek. Therefore a number of comprehensive remediation alternatives were formed by combining the various remediation methods listed above. The comprehensive remediation alternatives that met the screening criteria and were subjected to a detailed evaluation included:

- Shallow Excavation, Disposal Onsite, Creek Rehabilitation with optional enhancing features:
  - In-Place Capping
  - Flow Regulation
- Deep Excavation, Disposal Onsite, Creek Rehabilitation

These comprehensive remediation alternatives were then evaluated using detailed evaluation criteria that considered technical, cost, natural environment, and social factors. The onsite and offsite portions of the Young's Creek Area were evaluated separately due to significant differences in the onsite and offsite portions of Young's Creek (i.e. water depth, contaminant level, and property ownership).

The detailed evaluation resulted in the following recommended remediation alternative for the Young's Creek Area for onsite and offsite areas, respectively:

- Deep Excavation, Disposal Onsite, Creek Rehabilitation
- Shallow Excavation, Disposal Onsite, Creek Rehabilitation

1.5 Overview of the Recommended Alternative

The recommended remediation alternative for the Young's Creek Area is shown schematically in Figure 1-4. The recommended alternative consists of excavating contaminated sediment (both onsite and offsite portions) and underlying contaminated soil (onsite portion only) from the Young's Creek Basin. The excavated sediment and soil will be dewatered and stored in a newly constructed onsite secure containment cell located to the south of the Tailings Area. Following excavation of contaminated material from the Basin, two constructed wetland parcels and a perimeter wetland shelf will be created in the Young's Creek Basin.

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CONSTRUCTED WETLAND PARCEL
DOMINATED BY RIVERINE MARSH HABITAT
• SPECIES COMPOSITION CONSISTS OF NATIVE SHRUBS, SEDGES, RUSHES, GRASSES, EMERGENT AND SUBMERGENT SPECIES
DEEP ZONE
SHALLOW EMERGENT SHELF
DEEP ZONE
PASSIVE RESTORATION WETLAND AREA
NORMAL WATER LEVEL
CONSTRUCTED WETLAND PARCEL
N.T.S.
1
DELORO VILLAGE
SECURE CONTAINMENT CELL FOOTPRINT
YOUNG'S CREEK
CONSTRUCTED WETLAND PARCEL SEE TYPICAL DETAIL
NORTHERN POND
CENTRAL POND
SOUTHERN POND
WETLAND SHELF SEE TYPICAL DETAIL
WETLAND SHELF
DOMINATED BY RIVERINE MARSH HABITAT
• SPECIES COMPOSITION CONSISTS OF NATIVE SHRUBS, SEDGES, RUSHES, GRASSES, EMERGENT AND SUBMERGENT SPECIES
• WETLAND CELLS WILL BE USED TO REVEGETATE WETLAND SHELF AREA
- 10 CELLS/HECTARE OF SHELF AREA
NORMAL WATER LEVEL
WETLAND SHELF
N.T.S.
2
LEGEND
PROPERTY LINE
SCALE
NOTE
TOPOGRAPHY DERIVED FROM AERIAL PHOTOGRAPH BY NORTHWAY MAP TECHNOLOGY LIMITED (MAY 5, 1992)
Ministry of the Environment
Ontario
CH2MHILL
REHABILITATION OF THE DELORO MINE/REFINERY SITE
FIGURE 1-4 YOUNG'S CREEK AREA PLAN VIEW OF RECOMMENDED REMEDIATION ALTERNATIVE
DEEP EXCAVATION ONSITE
SHALLOW EXCAVATION OFFSITE

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1.6 Key Components and Recommended Alternative

1.6.1 Site Preparation

Prior to commencing the remedial work, site preparation work will be completed that includes mobilization of equipment (excavators, trucks, dewatering pumps and equipment, site trailers), construction of access roads where required, and establishment of temporary services. It is proposed to complete the excavation work in the "dry"; therefore, any ponded water will need to be drained prior to excavation. Sediment control measures will need to be implemented to minimize the transport of disturbed sediment from Young's Creek to the Moira River.

1.6.2 Excavation

For the onsite portion of Young's Creek, this alternative consists of excavating the upper most highly contaminated organic and red mud sediment, as well as the less contaminated underlying soil. The resulting removal depth for onsite sediment and soil ranges between 1.0 m and 1.5 m. Some of the upper onsite sediment are radioactively contaminated and radiation protection controls must be in place during their handling. For the offsite portion of Young's Creek, only the upper most impacted sediment (approximately the upper 0.5 m) will be excavated and any marginally impacted sediment will be left. These marginally contaminated sediment, while exceeding the Severe Effect Level (SEL), will have metal contaminant concentrations similar to those existing in the Moira River as well as in Moira and Stoco Lakes.

It is anticipated that the excavation work can potentially be conducted during all seasons of the year. The trial excavation of frozen Young's Creek sediment by CH2M Gore & Storrie Limited in March 1999 (CH2M HILL, 2001) indicated that it is feasible to excavate materials in the winter when the ground is frozen. The ice and frost cover offers a stable work platform if water under the ice is pumped out during freeze-up. In addition, water management conditions may be better during the colder months. However, there are a number of disadvantages associated with excavation of sediment in winter. Sediment excavated in below-freezing temperatures will need to be dewatered in the spring, prior to transfer to the secure onsite containment cell. Therefore, a large volume of sediment requiring dewatering in spring may delay the commencement of dewatering of other new sediment/soil excavation in the spring. In addition, access may be difficult due to snow cover, inclement weather can significantly affect the efficiency of the excavation operation, and the frozen sediment may adhere to truck's boxes, unless they are heated. As a result, winter excavation is not shown in the cleanup schedule (Figure 4-1); however, limited excavation work may still be feasible in winter.

Water management that involves controlling flows in Young's Creek during the excavation and storage of the materials will be required throughout the project. Flows from upstream portions of Young's Creek, as well as stormwater within the active excavation areas, will be diverted to avoid standing water in the area being excavated. Dewatering of the sediment and soil will be required prior to placement in the secure onsite containment cell.

The excavated sediment and soil will be moved to a staging area for dewatering and consolidation prior to storage onsite. The estimated volume of contaminated sediment and

soil requiring excavation is approximately 199,000 m^3 from the onsite portion, and 68,000 m^3 from the offsite portion resulting in a total of approximately 267,000 m^3 (see Section 3.3.3). These sediment and soil will be disposed of in a secure containment cell that will be located in an area adjacent to the Tailings Area as shown in Figure 1-4. The containment cell for the contaminated sediment and soil will be engineered and maintained to prevent future release of contaminants to the environment.

1.6.3 Secure Onsite Containment Cell

The containment cell will have engineered cap and liner systems that will be designed to prevent contaminant releases to the environment. The cap will consist of a vegetated cover, 150 mm of topsoil, 1,000 mm of compacted fill, 300 mm cap drainage layer, and a geosynthetic clay liner to prevent infiltration of surface water. The cap will be designed to promote runoff and evapotranspiration, thereby reducing the amount of precipitation that could come into contact with the contaminated sediment in the containment cell. The cap includes a drainage system to intercept any percolating water that does not run off or is not evapotranspired before it contacts the stored sediment. This clean infiltrating water collected in the cap system will be directed to Young's Creek.

The base liner system will consist of a 1,000-mm thick clay liner and a high density polyethylene (HDPE) liner with a leachate collection system as a backup measure to collect any water that does happen to penetrate the cap system. The liquid collected by the leachate collection system will be collected in sumps and stored in a holding tank for pumping and transport to the onsite treatment facility when necessary. The containment cell will be located above the water table to prevent groundwater contact with stored sediment/soil.

1.6.4 Creek Rehabilitation

The majority of the remediated area will be restored allowing the local seed bed to regenerate the wetland plant community naturally. It is expected that if appropriate hydrological conditions are established that are relatively consistent with the existing wetlands, the environment will be ideal for the utilization of this restoration method. In addition, more intensive planting using local seed material and potted plant stock is suggested at select locations within the creek corridor. Water quality improvements associated with wetlands would be the primary benefit derived from quick wetland establishment. To hasten the establishment of the wetland, two wetland parcels and a perimeter wetland shelf will be constructed as shown in Figure 1-4.

The wetland parcels will be installed at two strategic locations. One wetland parcel will be installed at the southern extent of the creek upstream of Highway 7. The other wetland parcel will be installed at the lower end of the Southern Pond, prior to the point of discharge at the Moira River. The wetland parcels will provide some level of treatment and filtration prior to the discharge of creek water into the Southern Pond and the Moira River. The construction of the wetland parcels will involve placement of fill material in the two locations to create the appropriate hydrology to establish a shallow emergent shelf. Planting of native shrubs, sedges, rushes, grasses, and emergent/submergent species by both seed and transplanting will be completed.

Construction of the wetland shelf will consist of grading to provide littoral zones around the perimeter of the ponded areas. The shelf will be graded to provide an optimum water depth to support a diverse wetland community associated with the dominant riverine marsh habitat. The shelf will be continuous around the perimeter and have varying widths based on aesthetic and MNR requirements. A 75 to 100 mm depth of topsoil will be required on top of the wetland shelf to provide an ideal environment for seed germination and subsequent root development. The shelf will provide limited treatment potential, but will stabilize the soil and serve an aesthetic function. A series of wetland planting cells will be initiated at strategic locations throughout the wetland perimeter shelf. The wetland planting cell is an approximately 10-m by 10-m area within which a specific plant mix is established that consists of seed and potted plant stock. The wetland planting cells replace the seed bed contained in the upper 500 mm of stripped soil and the substrate seed bed that was covered with 300 mm of imported soil.

2. Technical Studies and Supporting Documentation

2.1 Human Health and Ecological Risk Assessment

The MOE has developed guidance documents specific to the SSRA approach, which have been followed for this project. CH2M HILL has conducted SSRAs for both the human health and ecological risks for all areas of the site, based on the remediation alternatives recommended for each area of the site and for various exposure scenarios and receptors. Results of these simulations have been used in the closure plans to modify and optimize the conceptual remediation designs first presented in the rehabilitation reports, as well as to satisfy the site-wide closure objectives. The SSRA also supports a Pathways Analysis, which is anticipated as part of the Canadian Nuclear Safety Commission (CNSC) license application (see Section 2.2).

In support of the rehabilitation program and as part of the development of the final cleanup plan, CH2M HILL completed a draft screening level ecological risk assessment (SLERA) and a draft human health risk assessment (HHRA) to assess the risks associated with the Deloro Mine Site and Young's Creek offsite area following rehabilitation. The risk assessment was completed for the entire site, including the four main areas. This section presents a summary of the findings of the Mine site SSRA and Young's Creek offsite area SSRA, respectively. Complete details concerning the HHRA and SLERA are provided in the following reports:

- *Deloro Mine Site Cleanup – Deloro Mine Site Site-Specific Risk Assessment. Draft Report.* (CH2M HILL, May 2003)
- *Deloro Mine Site Cleanup – Offsite Young's Creek Site-Specific Risk Assessment. Draft Report.* (CH2M HILL, May 2003)

2.1.1 Summary of SSRA Results

The results of the draft SSRAs performed at the Deloro Mine Site and in Offsite Young's Creek are summarized below for the expected post-closure conditions. Additional information is provided in the executive summaries of the respective draft reports.

Human Health Risk Assessments (HHRA)

- All chemicals of concern (COCs), with the exception of arsenic, show results below the MOE recommended target of 1×10^{-6} for carcinogenic risk. It is the opinion of CH2M HILL that comparison to the typical Ontario resident (TOR) is more appropriate for qualification of carcinogenic arsenic risk. The carcinogenic risks for arsenic were determined to be less than the risk to a TOR for all scenarios, receptors, and routes of exposure.

- Risk identified at levels greater than the MOE recommended target hazard quotient (HQ) of one for non-carcinogenic risk were identified for the onsite Child Recreational User due to exposure to soil (onsite), sediment (onsite and offsite) and surface water (offsite). The elevated post-closure risk results may be mitigated with expansion of the areas to be excavated and/or covered as part of the recommended rehabilitation alternative, or, the results may be confirmed with additional sampling to confirm assumptions made in order to fill in the data gaps (see further discussion in 2.1.4 below).
- Young's Creek offsite post-closure Recreational User receptor risks were well below the comparison values previously identified. This may indicate that the rehabilitation effort originally proposed as part of the recommended rehabilitation alternatives reports can be reduced, assuming it also meets the requirements of acceptable risk to ecological receptors.
- Carcinogenic and non-carcinogenic risk due to ingestion of arsenic in onsite and offsite diet media (fish, ruffed grouse, berries) was greater than both the TOR and the HQ of one, respectively, for the Child and Adult Recreational Users. Confirmation of the presence and consumption of the diet media, as well as additional ecological data, is required to confirm these results.

Screening Level Ecological Risk Assessments (SLERA)

- Arsenic and cobalt are the COCs that are the main drivers of the elevated risk to onsite ecological receptors, as well as both pre- and post-closure Young's Creek offsite ecological receptors. Additional metals such as nickel, copper, chromium, and boron have also been identified as contributing to elevated risk to ecological receptors onsite and offsite.
- The results show that it is the concentration of the aforementioned COCs in soil that is of primary concern; however, elevated risk results have also been determined due to exposure to COCs in sediment and surface water.
- Almost all of the ecological receptors modelled show elevated risk at the screening level due to one or more COCs for one or more routes of exposure.
- A significant degree of uncertainty is associated with the draft results due at the screening level to lack of site-specific information and assumptions made in order to fill in data gaps.

2.1.2 Key Points

The following items should be considered in determining a path forward for the SSRA:

- The draft risk results for some pathways and receptors (both ecological and human) were not calculated using site-specific data, instead, engineering assumptions and literature-derived information were used.
- The risks to ecological receptors are not conclusive given the information that is currently available.
- The results of the draft human health risk assessment indicate that further risk reduction efforts are required should the future land use allow recreational users on the onsite property.

- Risk to both ecological and human health receptors may be mitigated by extending cleanup to a larger area, or by addressing the aforementioned data gaps by undertaking a focused field program.

2.1.3 Primary Issues of Concern

Based on the information presented above, there are two issues of primary concern. These arise because previous sampling work has focused on delineation of impacted areas for cleanup with relatively little focus on the post-closure conditions. The two primary issues are: (i) the absence of analytical data for certain chemicals in specific media, and (ii) the lack of site-specific information required to evaluate the potential risk due to exposure to the chemicals present.

2.1.4 Revisions to Recommended Rehabilitation Alternatives

The recommended modifications to the recommended rehabilitation alternatives, which were identified through completing the draft SSRAs, included:

- Expansion of coverage around the western perimeter of the Industrial Area
- Total coverage of the Main Mine Area
- Excavation and/or capping of selected areas west of the Tailings Area to the Moira River
- Excavation of sediment from the Young's Creek Offsite area just south of Highway 7
- Excavation of sediment from the Young's Creek Offsite area just north of the confluence with the Moira River

In addition, in order to prevent exposure to burrowing animals as part of the SLERA (as well as due to the potential risk of transmigration of contaminants via tree roots), the thickness of any capped areas was increased to be at least 1.5 m^2. These recommended modifications to the recommended rehabilitation alternatives are addressed in the Closure Plan for each area of the site.

2.1.5 SSRA Recommendations

The SSRAs provided to the MOE documented the presence of metal contaminant-related issues within the Deloro mine onsite area and Young's Creek offsite area under the post-closure condition for the recommended rehabilitation alternative. While the SSRA results did not show unacceptable risk under most conditions, it also indicated that there were potential risks to plants and animals residing within these areas, as well as to humans spending time on the respective properties, in some circumstances. The extensive characterization work at the site has focused on the areas requiring remediation, with less effort directed to areas that will remain post-closure. As a result, the data used to define the nature and extent of post-closure contamination and subsequent risk, or to establish acceptable risk-based cleanup levels, is being augmented through further investigative work. Further, the conclusions for potential risks to ecological receptors/valued ecosystem components (VECs) were primarily based on published reference values consistent with a screening level risk assessment (e.g.

[2] With exception, the cap thickness over slag and waste rock in the Industrial Area and Mine Area, respectively, was set at 0.65 m since these materials are not bio-available.

GUCSO). These values are not specific to this site, the activities that have taken place, or the types of contaminants present. In order to confirm that the recommended alternatives are appropriate and that remediation is not required over a broader area of the site (beyond the areas identified on the Closure Plans), additional site information is being collected and further risk evaluation is underway.

The results of the supplementary site information and risk assessment will be used to fill in the data gaps, increase the confidence in the risk evaluation, and update the draft results of the HHRA and SLERA for both the Deloro Mine Site SSRA report and Young's Creek Offsite SSRA report. The revised reports will be prepared in a format that is suitable for submission to the Standards Development Branch (SDB) of the MOE for their review following the additional work. If necessary, the Closure Plans will be revised to address additional areas of the site that need to be capped or excavated.

The following briefly lists the studies that are ongoing to verify and substantiate the conclusions of the SLERA and the HHRA:

- Additional chemical characterization of onsite soil, sediment, and surface water
- Collection of biota co-located with soil, sediment, and surface water samples for evaluation of site-specific bioaccumulation
- Biological and physical surveys within the Young's Creek onsite area
- Toxicity testing of the Young's Creek onsite area
- Bioavailability of COCs in soil, sediment, and surface water

2.2 Environmental Assessment

The MOE is seeking the necessary approvals to undertake a project involving the long-term onsite management of historic wastes, contaminated soil, and low-level radioactive waste (LLRW) currently located at and in the vicinity of the Deloro Mine Site. The MOE understands that the licensing requirements for radioactive materials management under the *Nuclear Safety and Control Act* (NSCA) require that an Environmental Assessment (EA) under the CEAA be completed.

A report was prepared entitled *Deloro Mine Site Cleanup, Project Description, Final Report* (CH2M HILL, November 2002) to provide the appropriate federal authorities with a project description and related information to initiate the federal EA process under the CEAA. The project description provided relevant project site information and an overview of the anticipated construction, operation, remedial work, long-term monitoring, and consultation activities that will be undertaken as part of the cleanup of the Deloro Mine Site, including the offsite portion of Young's Creek.

The CNSC, in co-operation with the federal Department of Fisheries and Oceans Canada (DFO), subsequently prepared a document entitled *Environmental Assessment Guidelines (Scope of Project and Assessment), Environmental Assessment of the Deloro Mine Site Cleanup, Deloro, Ontario* (CNSC, October 2003). The purpose of the latter document is to provide guidance on the scope of a screening level EA to be conducted for the possession, management, and storage of nuclear substances at the Deloro Mine Site.

The CNSC notes in its EA Guidelines that a federal EA is required under the provisions of the CEAA. Under the CEAA, the scope of the project and the scope of the factors included in the assessment are determined by the Responsible Authority (RA) for the project. The RA for this project is the CNSC. The DFO has indicated that it is an RA for this project if an authorization under the *Fisheries Act* is required; however, if it is not required, the DFO will withdraw as an RA but will remain as a Federal Authority (FA) for the project. The EA Guidelines describe the basis for the conduct of the EA and focus the assessment on relevant issues and concerns. This document also provides specific direction to the proponent, the MOE, for the conduct and documentation of the technical EA study report, the responsibility for which will be delegated to them by the CNSC and DFO pursuant to subsection 17(1) of the CEAA. The EA Guidelines also provide a means of communicating the EA process to stakeholders.

CH2M HILL is currently preparing the EA study report on behalf of the MOE and it will draw upon this and other Closure Plans.

2.3 Assessment of Likely Cumulative Effects

According to the CEAA, an EA must include an assessment of cumulative effects. CH2M HILL is addressing the assessment of cumulative effects in the EA study report. Cumulative effects will include an assessment of the potential effects of the Deloro Mine Site project in combination with the effects of other projects. In order to have a cumulative effect, the works and activities associated with other projects must overlap with both the geographical area and time frame of the Deloro Mine Site cleanup project. The cumulative effects assessment will be focused on the consideration of potential effects to valued ecosystem components (VECs) and valued social components (VSCs). If a cumulative effect is likely, then mitigation measures are applied and the potential effect is reassessed. If residual effects are identified after the reassessment, their significance will also be determined.

2.4 Other Studies and Evaluations

Previous investigations completed in the Young's Creek Area are summarized in the Young's Creek Area Rehabilitation Alternatives Report (May 2003). Two recent additional studies not discussed above, but currently in draft and under review by the MOE, were utilized in this report. They are:

- *Results of the July 2003 Geotechnical Investigations for the Deloro Mine Cleanup Project, Draft Technical Memorandum* (CH2M HILL, December 2003)
- *Results of 2003 Characterization of Groundwater Quality in the Vicinity of Young's Creek, Deloro Mine Cleanup Project, Draft Technical Memorandum* (CH2M HILL, March 2004)

2.4.1 July 2003 Geotechnical Investigation Summary

Supplementary geotechnical investigative work was completed by CH2M HILL on the Deloro Mine Site in July 2003. One of the objectives of the July 2003 Geotechnical Investigation was to provide a better understanding of the geotechnical conditions in the

vicinity of the secure containment cell proposed in the Young's Creek Area. Two boreholes were drilled and four test pits were excavated in the footprint of the proposed containment cell.

The investigation revealed that overburden thickness was variable, ranging from 0 m(outcropping) to 2.7 m. Overburden soil types were also variable and ranged from silty sand to silt and clay. Organic soil was also found in low-lying wet areas.

The investigation concluded that existing overburden soil would not likely be suitable for use in the containment cell liner system and that an offsite source of clay material should be considered to construct the clay liner. Another important conclusion resulting from the investigation was that the variable overburden soil type and thickness could potentially adversely affect the performance of the containment cell's base liner system due to differential settlement concerns. It was recommended that the final design of the base liner should address differential settlement concerns by founding the base liner on similar soil types and conditions. Containment cell site preparation activities including rock blasting, overburden excavation, compaction and grading will be required to create a suitable foundation for the containment cell liner.

2.4.2 2003 Groundwater Characterization Summary

Supplementary groundwater characterization work was completed by CH2M HILL in the Young's Creek Area of the Deloro Mine Site in July and December 2003. The primary objective of this work was to assess groundwater quality in the vicinity of Young's Creek. Three bedrock wells and two overburden wells were installed in the Young's Creek Basin for the purposes of hydraulic testing and groundwater sampling.

The results of the investigation revealed that groundwater quality in the bedrock wells were less than the MOE GUCSO Table A criteria with the exception of one bedrock well which exceeded the criteria for copper. This bedrock well, located near Highway 7, had a total copper concentration of 0.0358 mg/L, greater than the Table A criterion of 0.023 mg/L. While copper is a known contaminant in soil and surface wells at the site, the concentration of copper at a monitoring well closer to the Tailings Area was present at background levels (CH2M HILL, March 2004). Groundwater quality in the overburden wells met Table A criteria with the exception of arsenic and mercury for the overburden well closest to the Tailings Area.

The investigation concluded that, based on the limited results, the groundwater beneath Young's Creek does not appear to be extensively impacted. It was recommended that the five new wells installed in the vicinity of Young's Creek be incorporated into the existing monitoring well network and long-term monitoring program.

3. Description of the Recommended Alternative

The recommended alternative consists of excavating contaminated sediment and soil from the Young's Creek Basin and placing it in a newly created secure onsite containment cell. The major activities associated with the recommended alternative are summarized as follows:

- Site preparation activities, including clearing and grubbing in the proposed containment cell location, construction of staging areas in the creek basin for sediment/soil dewatering, construction of temporary diversion dams and channels within the basin to allow dry excavation, construction of sedimentation basins to maintain total suspended solids concentrations at acceptable levels, and construction of decontamination pads, as appropriate, for excavation activities to take place offsite south of Highway 7
- Construction of a secure containment cell liner system and associated works
- Excavation of contaminated sediment/soil, transport, and placement in the secure onsite containment cell
- Capping and vegetation of the secure containment cell
- Creek rehabilitation measures including a perimeter wetland shelf and constructed wetland parcels
- Long-term operation, maintenance, and monitoring (OMM) of the secure containment cell and associated works

Specific details associated with the recommended alternative are provided in this section.

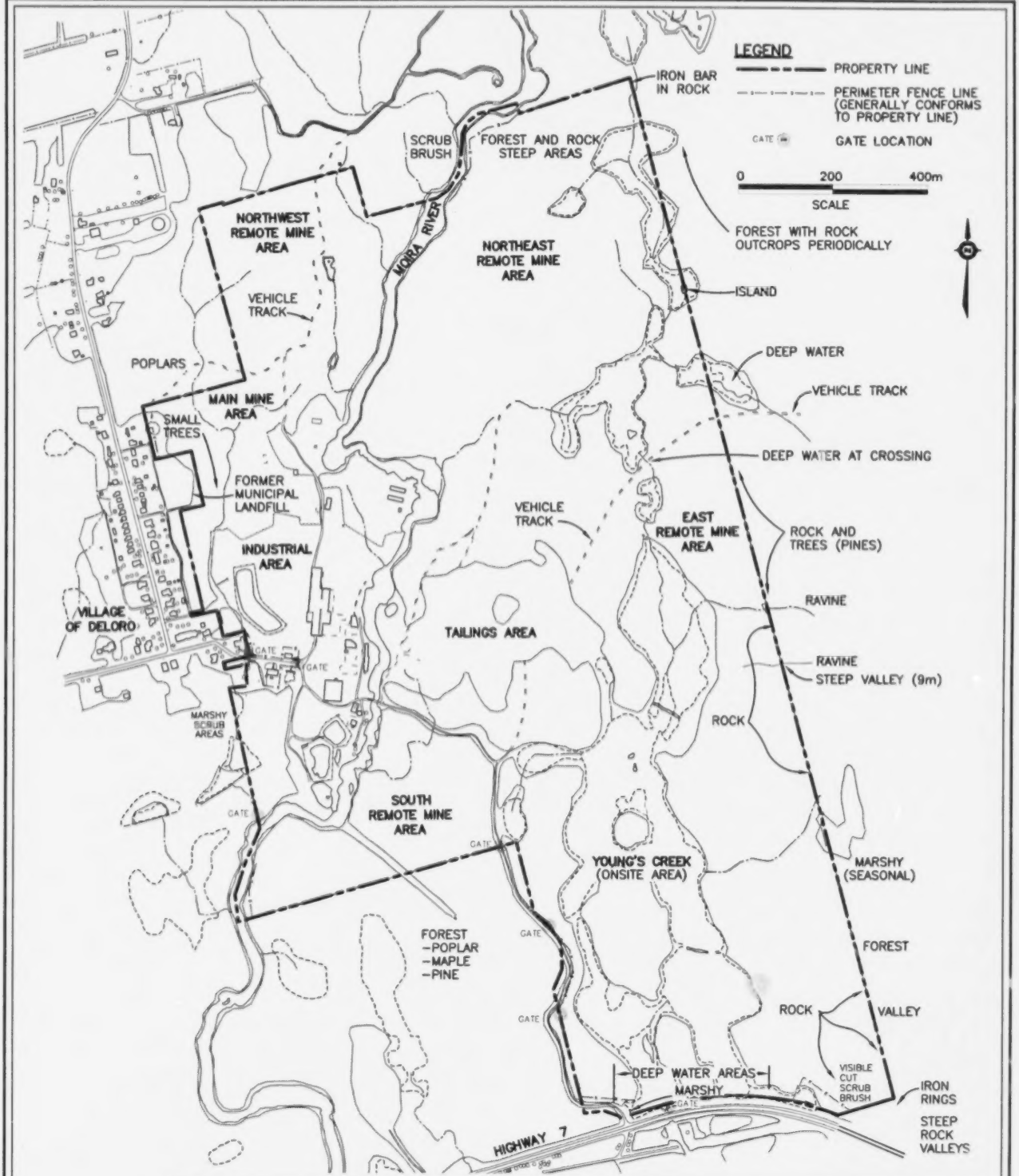
3.1 Site Security and Safety

The Deloro Mine Site and the Ontario Clean Water Agency (OCWA) compound are completely enclosed by a 7,606 m perimeter fence that was completed in March 2000 (Figure 3-1). The majority of the chain link perimeter fence was installed to a height of 2.13 m, including 0.30 m of barbed wire. Adjacent to Highway 7, the perimeter fence was installed to a height of 2.13 to 2.44 m, without barbed wire to satisfy the Ministry of Transportation's Permit requirements.

There are seven points of entry to the site, mainly along the southern and western property boundaries, including five 9.0-m wide gates (includes one 9.0-m wide gate installed in 2003), one 6.0-m wide gate, and one 1.2-m wide gate. The access gates will remain closed if not in use during the day and all gates will be closed and locked at the end of each working day to prevent public access to the site during remediation activities.

Access to the Industrial Area will be through the main site access gate near the ATP. The existing onsite access road will be used for construction vehicles to access these areas.

17/JUNE/2004



CH2MHILL

DELORO MINE SITE CLEANUP

FIGURE 3-1
PLAN OF PERIMETER FENCE

PROJECT No. 119548

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A group of three signs are affixed to the fence at distances varying between 50 m and 200 m, which read as follows:

- *Danger, No Trespassing, Positively No Admittance* (25 cm by 36 cm)
- *Caution, Radiation Area, Radioactive Materials, Authorized Personnel Only* (25 cm by 36 cm)
- *Mine Hazard Area, Danger: Every person who alters, impairs, or destroys this notice, this fence or any rehabilitation work made in accordance with Part VIII of the Mining Act, is guilty of an offence and, upon conviction, is liable to a fine of not more than $30,000* (30 cm by 30 cm)

During the construction phase of the project, signs will be used to caution the public along Highway 7, in the Village of Deloro, and at site entrances. Signage may include *"Trucks Turning"* and other construction warning signs as well as *"Danger – Access By Permit Only"* at access gates. Additionally, flagmen may be needed along Highway 7 to control traffic when heavy machinery or large transport trucks enter or exit the highway.

The safety of workers and the community and environmental protection are discussed in Section 4.6 (Health Hazard Assessment) and Section 4.7 (Environmental and Community Health Protection Plan).

Property ownership in the offsite portion of Young's Creek is private and the planned remediation activities will require the consent and cooperation of the property owners. Prior to work being conducted, a 1.8-m high chain link fence will be installed around portions of the perimeter of the offsite portion of Young's Creek near key access points (i.e. road areas or other areas where a higher potential for public access exists). In other more remote and inaccessible areas, it will be determined during the final remedial design if temporary fencing is sufficient or required to further restrict public access to the work area. Following remediation of the offsite portion of Young's Creek, any perimeter security fencing erected during the implementation of the project will be removed.

Traffic safety measures for the Young's Creek Area work will include the use of signs to caution the public along Highway 7 and at site entrances. Signage may include *"Trucks Turning"* and other construction warning signs on Highway 7 as well as *"Danger – Access By Permit Only"* at access gates. Additionally, flagmen will be needed along Highway 7 to control traffic when heavy machinery or large transport trucks enter, exit, or cross Highway 7 to enter the access road that runs along the western side of the onsite Young's Creek Area.

Access to the Young's Creek Area (onsite) and the proposed secure containment cell will be by the access road off Highway 7. An assessment and reconstruction of the onsite bridge crossing the Moira River was recently completed as reported in CH2M HILL's report entitled, *Deloro Mine Site Rehabilitation Project – Assessment and Reconstruction of Deloro Mine Site Bridge, Final Report* (CH2M HILL, June 2002). The key conclusions and recommendations of the report are:

- The existing site bridge in 1998 was not suitable for the future construction activities.
- Although the site bridge was reconstructed in 2000, there will be loading limitations during site rehabilitation. The following equipment should not be permitted to cross the reconstructed site bridge:
  - A medium-tracked excavator

  - A loaded articulated truck
  - A loaded four-axle truck
- If future contractors plan to use other types of trucks with different axle spacing and loadings, then further analysis should be carried out by a design professional.
- The need for construction equipment to cross the Moira River during site rehabilitation should be assessed after completion of the various Closure Plans to prevent exceedances of the reconstructed bridge's loading capacity.

Access to the Young's Creek Area (offsite) will be by the access road to the Quinte Conservation's (QC's) Ackerman Conservation Area off Highway 7. Old Marmora Road at the south end of the Young's Creek Basin is another potential access point.

3.2 Building Demolition

There are no existing buildings associated with the onsite or offsite portion of the Young's Creek Area.

3.3 Waste Removal and Handling

Wastes requiring excavation and handling are the metal-contaminated sediment and underlying silty-clay soil within the Young's Creek Basin. Some of the onsite sediment also have radioactive contamination. The areal extent of contaminated sediment and underlying soil is shown in Figure 3-2. This section identifies and provides an inventory of the contaminated sediment and soil. It also describes the excavation, loading, hauling and dewatering of contaminated sediment and underlying soil prior to placement in the secure onsite containment cell. Radiation protection and contamination control procedures (Section 4.6) will be in effect during the excavation and handling of the radioactively contaminated sediment.

3.3.1 Main Waste Types

The main waste types that will be generated during the Young's Creek Area closure activities will be metal contaminated organic sediment, as well as underlying metal contaminated silty-clay soil. The organic sediment (upper 0.5 m) onsite are also contaminated with radium and uranium from wastes eroded from the Tailings Area.

3.3.2 Miscellaneous Wastes

Miscellaneous wastes generated during rehabilitation activities in the Young's Creek Area will result from the clearing and grubbing of the area proposed for the secure containment cell. Fallen trees will be mulched and stored onsite for future use on the vegetative cover. Excess rock, resulting from blasting activities in the proposed secure containment cell area, will be crushed onsite for use as a granular material in the construction of the containment cell. Excess topsoil and overburden soil will be stockpiled onsite and could be used to construct the engineered cap of the containment cell.

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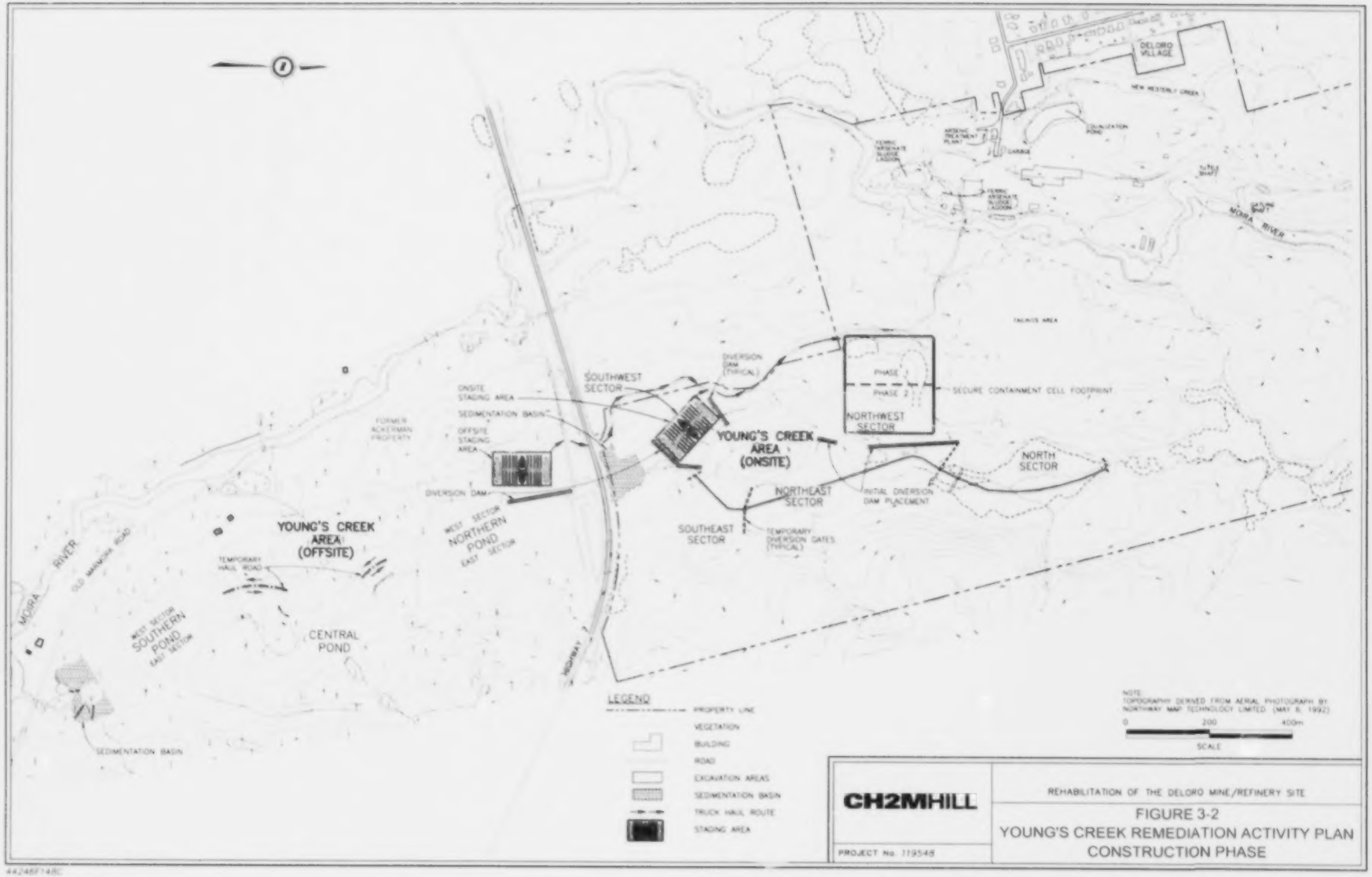

CH2MHILL

REHABILITATION OF THE DELORO MINE/REFINERY SITE

FIGURE 3-2

YOUNG'S CREEK REMEDIATION ACTIVITY PLAN
CONSTRUCTION PHASE

PROJECT No. 119548

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3.3.3 Waste Inventory

The detailed estimate of contaminated sediment/soil volumes is provided in the report entitled *Deloro Mine Site Cleanup – Young's Creek Area Rehabilitation Alternatives, Final Report* (CH2M HILL, May 2003). The estimated quantity of contaminated sediment/soil provided in this report was 160,000 m^3 of contaminated organic sediment and 99,000 m^3 of underlying contaminated silty-clay soil. Work completed as part of the SSRA revealed that an estimated 8,000 m^3 of additional contaminated sediment exist in the Young's Creek Basin (refer to Section 2.1.4). The revised volumes of contaminated sediment/soil in the onsite and offsite portion of Young's Creek are summarized in Table 3.1. In summary, there is an estimated 168,000 m^3 of contaminated organic sediment and 99,000 m^3 of underlying contaminated silty-clay soil that will require excavation, onsite transportation, and storage in the secure onsite containment cell.

TABLE 3.1
CONTAMINATED SEDIMENT/SOIL IN THE YOUNG'S CREEK AREA

Location	Average Thickness (m)	Volume (m^3)	As Concentration (µg/g) High/Average	Sediment/Soil Type
Onsite	0 to 0.5 m	100,000	110,000/16,503	**Sediment**: Red silt/organic sediment
Onsite	0.5 to 1.2 m	99,000	7,500/1,800	**Soil**: Inorganic silty clay
Offsite	0.3 m	68,000	1,460/325	**Sediment**: Black organic peat/silt

The criteria used to guide the confirmatory sampling during completion of the future remedial activities will be the MOE SEL criteria or applicable criteria developed as part of the SSRA for the site. It is anticipated that following remediation, the sediment/soil quality will be similar to the ambient sediment quality in the Moira River, Moira Lake, and Stoco Lake.

3.3.4 Waste Excavation and Dewatering

Prior to the excavation of contaminated sediment/soil, temporary staging areas will be constructed. Two separate staging areas will be required, one for the onsite portion and one for the offsite portion of Young's Creek. The proposed locations of the onsite and offsite staging areas are shown in Figure 3-2. The staging areas will provide a stable work platform where wet contaminated sediment/soil can be dewatered and conditioned prior to placement in the secure containment cell. Clay diversion dams will be built as shown in Figure 3-2 to isolate the staging areas from potential flood waters.

The onsite and offsite staging areas will have an approximate area of 12,000 m^2. The onsite and offsite staging areas will allow sediment to be dewatered at a rate of approximately 1,000 m^3/day. These dewatering rates result in approximately 200 excavation days and 70 excavation days, respectively, being required for the onsite and offsite portions of Young's Creek. The staging areas will be constructed of 150 mm of compacted granular A over a non-woven geotextile underlain by 300 mm of crushed rock over another non-woven geotextile. Silt control fencing will be placed along the perimeter of each staging area to prevent the movement of sediment/soil from the staging area back to the creek basin. Sedimentation basins, as described below, that will be located at the downstream end of the

onsite and offsite portions of the creek basin will provide a back-up measure to the silt control fencing.

Once the staging areas have been constructed, two sedimentation basins will be created in the onsite and offsite portions of Young's Creek as shown in Figure 3-2. The sedimentation basins will be sized to allow any suspended sediment resulting from upstream excavation activities to settle out prior to discharge. The sedimentation basin for the onsite portion of Young's Creek will be created in the floodplain north of Highway 7 and will capture suspended sediment before being discharged to the culvert under Highway 7. For the offsite portion of Young's Creek, a sedimentation basin will be created in the southern portion of the Southern Pond to capture suspended sediment prior to discharge to the Moira River. Suspended sediment that accumulate in the sedimentation basins will be removed and placed in the secure onsite containment cell. For the relatively small portion of the creek between Old Marmora Road and the Moira River, sedimentation controls such as geotextile silt fencing, sand bags and/or straw bales will be used. This portion of the creek will be excavated during a low flow period to minimize suspended sediment transport to the Moira River.

Once the staging areas and sedimentation basins are in place, temporary diversion dams and ditches will be used to isolate specifed sectors of the creek basin. The temporary diversion dams will allow flow through the creek basin at all times during the work. In general, excavation activities will proceed in the downstream direction to prevent recontamination of remediated areas. The diversion dams will divert surface water flows around the active excavation area and will allow excavation work to proceed in the "dry". An initial potential diversion dam positioning is shown in Figure 3-2. The Northwest Sector should be excavated first to remove contaminated soil and sediment from the footprint of the containment cell. The initial placement of a diversion dam, as shown in Figure 3-2 will allow the Northwest Sector to be excavated in the "dry". Next, a diversion dam will be placed in a north-south orientation to divide the North Sector into an east and west half. Then the west half of the North Sector will be excavated while water is diverted through the east half. Once the west half of the North Sector is remediated, water will be diverted through the west half while the east half is remediated. Once the North Sector is remediated, the diversion dam will be moved downstream to the Northeast Sector and will divide the Northeast Sector into an eastern and western half. As in the North Sector, water will be diverted into one half while the other half is remediated. The Southeast Sector will be remediated in a similar fashion. The area comprising the sedimentation basin will be the last area to be remediated.

The diversion dams will have a base width of approximately 8 m, a top width of 1 m, and a height of 2 m above the existing creek bed. The elevation of the top of the diversion dam will be approximately 0.5 m higher than the flood water level to allow adequate freeboard. The dams will be constructed with a clay core and covered with a layer of rip rap to prevent erosion. Alternatively, portable sand-filled plastic bladders (called meter bags) may be used in the place of clay diversion dams to divert surface water. These portable units have a height of 1 m and can be stacked as needed to provide the necessary 0.5 m freeboard.

After the diversion dams are in place, any water existing in the sector under consideration will be pumped out into the adjacent portions of the creek on the other side of the diversion dams. After the water has been removed, contaminated sediment will be excavated using

track-mounted excavators, loaded, and transported to the staging areas using six-wheel drive articulating dump trucks. The use of these six-wheel drive vehicles will allow transport of contaminated sediment/soil from the excavation site directly to the staging areas without having to leave the creek basin. Crushed granular rock will be placed as required, within portions of the dewatered ponds of the creek basin, to create a temporary haul road from each excavation site to the staging area. This crushed granular rock will be removed and reused following the completion of a given sector. Stormwater in the area being excavated will be controlled as described in Section 3.5.1. Wastes will be dewatered and conditioned as described in Section 3.3.6. Following dewatering and conditioning, the sediment/soil will be loaded and transported to the secure onsite containment cell as discussed in Section 3.3.5.

Once excavation activities are completed, the granular A used to construct the staging area will be removed and disposed of in the secure onsite containment cell. The crushed stone underlying the granular A will be removed and stockpiled for future onsite re-use. Contaminated sediment/soil underlying the staging pads will be excavated and transported directly to the secure onsite containment cell. Dewatering of the sediment/soil will occur in the containment cell. The leachate from this dewatering will be collected by the leachate collection system.

3.3.5 Waste Transport

Dewatered sediment/soil will be loaded onto trucks and transported to the secure onsite containment cell. For the onsite portion of the excavation work, trucks will use the existing access road that runs parallel to the onsite portion of Young's Creek as shown in Figure 3-2. No offsite transport of contaminated sediment will be required for the onsite portion of Young's Creek. Temporary access roads are not required in the onsite portion of Young's Creek.

For excavation work in the offsite portion of Young's Creek, temporary access roads will be required between the ponds to permit movement of contaminated sediment from the Central and Southern Ponds to the staging area in the Northern Pond. These temporary access roads will be constructed at the proposed locations shown in Figure 3-2. The access roads will be approximately 5 m in width. Material used to construct the temporary access roads include a non-woven geotextile placed on the sub-grade, 300 mm of compacted granular B, followed by 150 mm of compacted granular A. As noted in Section 3.3.4, crushed granular rock will be placed, as required, to create temporary haul roads within portions of the dewatered ponds.

Following dewatering and stockpiling in the staging area, the contaminated sediment will be transported to the onsite containment cell along the route shown in Figure 3-2. The transport trucks will be required to cross Highway 7 at the location shown. The trucks will then use the access road that runs parallel and to the west of the onsite portion of Young's Creek to access the onsite containment cell.

3.3.6 Waste Conditioning

Prior to placement in the onsite containment cell, contaminated sediment and soil will require dewatering. Dewatering will occur in the onsite and offsite staging areas shown in Figure 3-2.

Excavated contaminated sediment and soil will be dewatered by placing the wet material in windrows, which will be approximately 1.5 m in height and 4 m in width. Windrows will be placed parallel, as shown in Figure 3-3, and be spaced approximately 4 m apart to allow an excavator to travel between the windrows. The excavator will move between the windrows and turn over the wet sediment/soil to promote dewatering and drying. Windrows will, in sequence, be moved closer to the stockpile location.

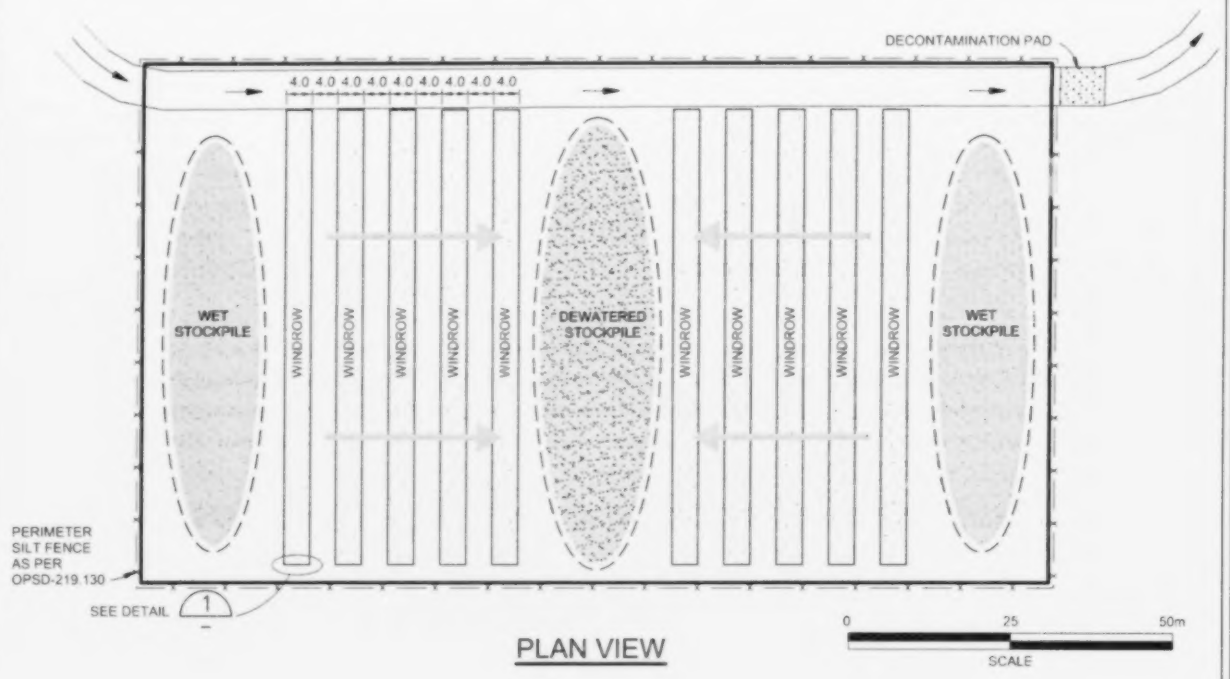
After approximately five turnover/movements, the sediment and soil should be dry enough to place into the dewatered material stockpile. Bulldozers will be used to create a ramped stockpile that will be approximately 5 m in height. The material stockpiles will eventually be loaded onto trucks for storage in the secure onsite containment cell.

3.4 Waste Isolation and Containment

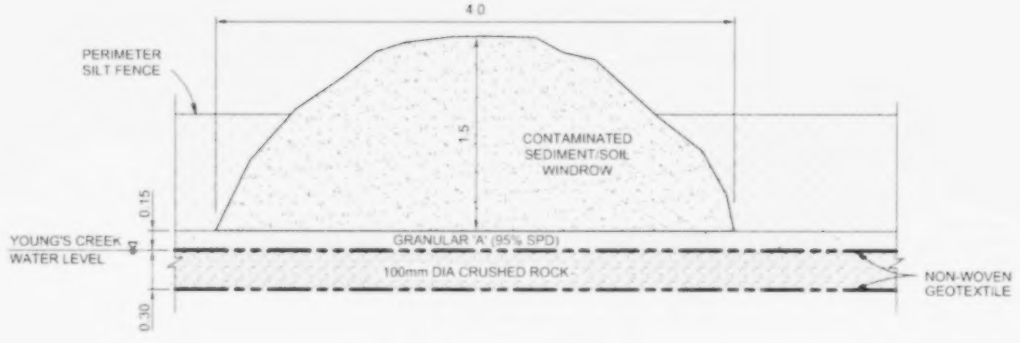
3.4.1 Design Description

Excavated sediment/soil will be placed in an engineered secure onsite containment cell. The proposed containment cell will be situated approximately 200 m south of the existing Tailings Area and approximately 600 m north of Highway 7. The footprint of the cell covers approximately 5 ha and will rise approximately 17 m above the existing Young's Creek bed. The containment cell will provide a capacity of approximately 270,000 m^3. It is recognized that depending on the results of the confirmatory sediment/soil sampling to be conducted during excavation activities, an increase in the actual total volume of material that requires excavation and containment in the secure containment cell may occur. As such, the final design capacity of the containment cell may need to be increased above the current estimate of approximately 270,000 m^3 to provide additional storage capacity.

The containment cell will have engineered cap and liner systems that will be designed to prevent contaminant releases. The cap will consist of a vegetated cover, 150 mm of topsoil, 1,000 mm of compacted fill, underlain by a geotextile, a 300 mm cap drainage layer of crushed granular material, and a geosynthetic clay liner within a 500 mm sand cushion and sand grading layer to prevent infiltration of surface water. The cap will be designed to promote runoff and evapotranspiration, thereby reducing the amount of precipitation that could come into contact with the contaminated sediment/soil in the containment cell. The cap includes a drainage system to intercept any percolating water that does not run off or is not evapotranspired before it contacts the stored sediment/soil. This clean infiltrating water collected in the cap system will be directed to Young's Creek. The thickness of the cap will also provide the necessary shielding to reduce radiation fields to be indistinguishable from background.



PLAN VIEW



DETAIL 1
1:25

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REHABILITATION OF THE DELORO MINE/REFINERY SITE

FIGURE 3-3
YOUNG'S CREEK AREA
STAGING PAD DETAIL

PROJECT No. 119548

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The base liner system will consist of 1,000-mm thick composite clay and high-density polyethylene (HDPE) liner with a leachate collection system embedded in a 300 mm granular drainage layer to collect any water that does happen to penetrate the cap system. The liquid collected by the leachate collection system will be collected in sumps and stored in a holding tank that will be pumped out as required and transported to the ATP in the Industrial Area. The containment cell will be located above the water table to prevent groundwater contact with stored sediment/soil.

3.4.2 Plans and Profiles

A plan view and cross-section of the proposed containment cell is shown in Figures 3-4 and 3-5, respectively.

3.4.3 Material Sourcing and Haulage Routes

Imported soil and granular materials will be required during the rehabilitation of Young's Creek. The types of materials, quantities required, purpose, and proposed source are summarized in Table 3.2.

TABLE 3.2
SUMMARY OF IMPORTED MATERIAL REQUIREMENTS

Material Description	Estimated Quantity (m^3)	Purpose
100 mm crushed rock	14,000	Temporary haul roads within creek basin
100 mm crushed rock	500	Secure containment cell rip rap erosion protection
100 mm crushed rock	6,000	Staging pad granular base
100 mm crushed rock	2,000	Temporary diversion dam erosion protection
Granular A	3,000	Staging pad granular base
Granular A	200	Temporary access road (offsite portion)
Granular B	400	Temporary access road (offsite portion)
50 mm crushed stone	115,000	Secure containment cell granular base
50 mm crushed stone	16,000	Secure containment cell cap drainage layer
Clay (Hydraulic Conductivity $<10^{-7}$ cm/s)	50,000	Secure containment cell clay liner
Clay (Hydraulic Conductivity $<10^{-7}$ cm/s)	10,000	Temporary diversion dam construction
Coarse to Medium Sand	27,000	Secure containment cell sand cushion layer for geosynthetic clay liner
Sandy Silt	53,000	Secure containment cell cover
Topsoil	8,000	Secure containment cell cover

Verification of offsite clay, sand and other material sources are currently being identified by CH2M HILL and will be completed during the design phase following acceptance of the Closure Plan.

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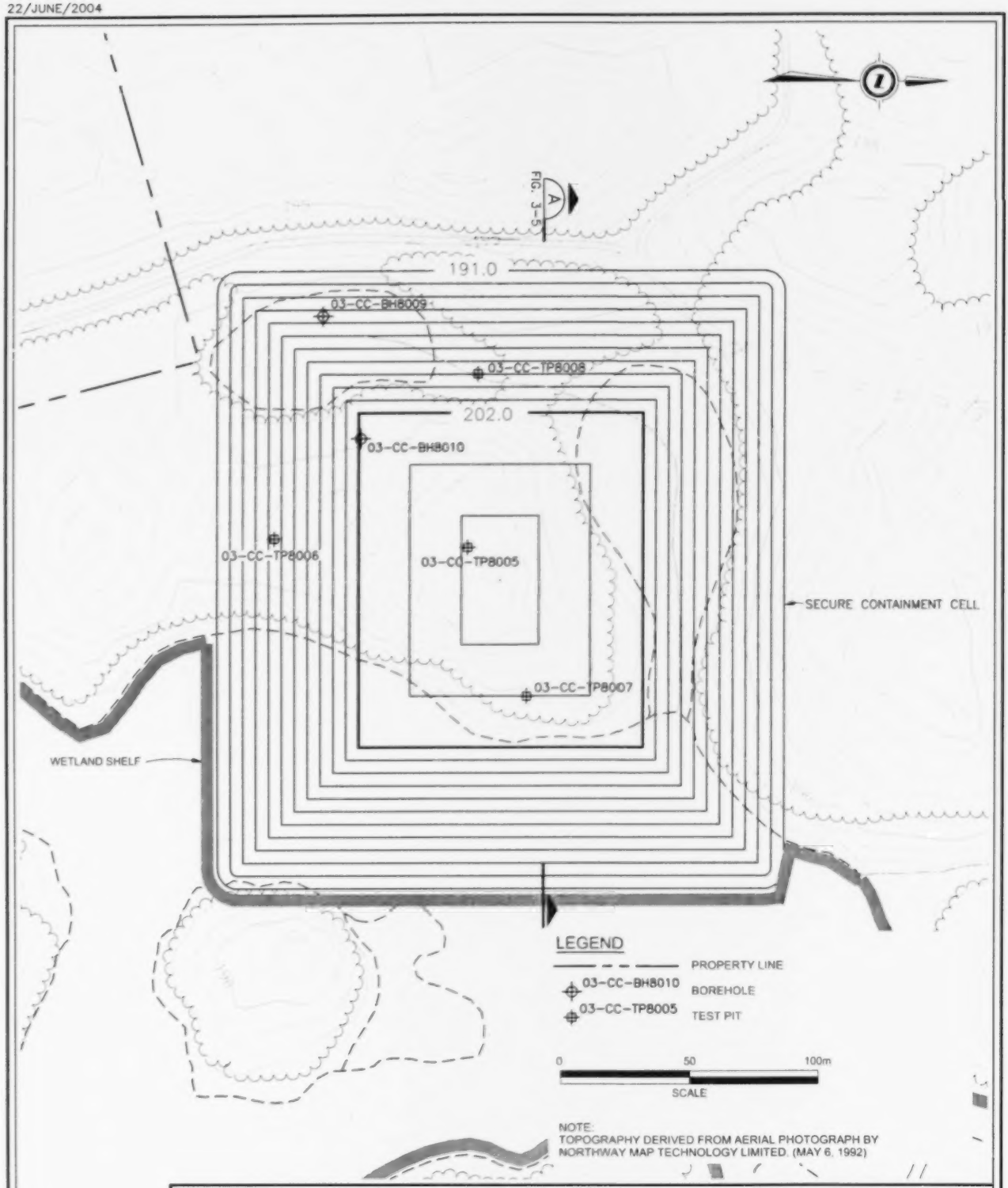

CH2MHILL

PROJECT No. 119548

REHABILITATION OF THE DELORO MINE/REFINERY SITE

FIGURE 3-4
CONCEPTUAL DESIGN YOUNG'S CREEK AREA
SECURE CONTAINMENT CELL PLAN VIEW

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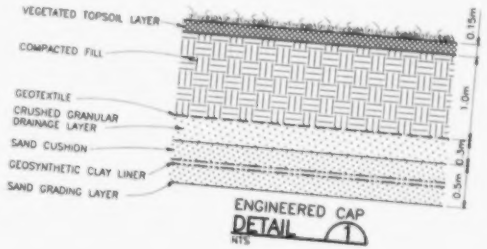
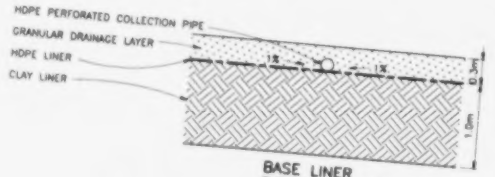


ENGINEERED CAP
DETAIL 1
NTS



BASE LINER
DETAIL 2
NTS

SECTION A
1:1000
FIG.3-4

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CH2MHILL	REHABILITATION OF THE DELORO MINE/REFINERY SITE
PROJECT No. 119548	FIGURE 3-5 CONCEPTUAL DESIGN YOUNG'S CREEK AREA SECURE CONTAINMENT CELL PROFILE

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3.5 Water Management

3.5.1 Surface Water and Stormwater Management

As discussed in Section 3.3.4, temporary diversion dams and ditches will be used to divert surface waters away from the area of active excavation. During rain and storm events, Young's Creek flows will be diverted around the active excavation area using temporary diversion dams. As previously discussed, the elevation of the top of the temporary diversion dam will be approximately 0.5 m higher than flood water levels to ensure adequate freeboard. Any water that exists prior to excavation or accumulates in the excavation during sediment/soil removal activities will be pumped out into the adjacent diversion channel. Mitigation measures addressing suspended sediment in surface water will include sedimentation basins installed downstream, as discussed in Sections 3.3.4 and 4.3.

Silt fencing will be placed around the perimeter of the staging and dewatering areas. Stormwater runoff from the staging areas will be diverted away from the active excavation areas and will pass through the sedimentation basins.

Rainfall percolating through any uncovered wastes that have been placed in the containment cell will be collected in the leachate collection system sumps and directed to the proposed holding tank for eventual removal and transport to the onsite ATP.

In addition to the management and control of silt and suspended sediment noted above, sampling and analysis of surface water quality at selected locations for analysis of arsenic and metals of concern will be conducted. Further details on surface water protection are provided in Sections 4.7.3 of this report and details related to surface water quality monitoring that will be conducted during the cleanup are provided in Section 6 of this report.

3.5.2 Groundwater Management

Groundwater that seeps into active excavation areas will be removed using submersible pumps. Sumps or low points will be created in active excavation areas where any infiltrating groundwater will drain and accumulate. Sump areas will be lined with a geotextile and crushed stone. The geotextile and crushed stone will surround the pump intake and act to remove suspended sediment. The accumulated groundwater/ rainfall/surface water run-on will be discharged to the diverted flow in Young's Creek.

3.5.3 Leachate Collection

Leachate generation will be minimized by using an infiltration water collection system in the engineered cap of the containment cell. Surface water infiltrating the engineered cap will be intercepted and diverted before it can contact the underlying stored contaminated sediment/soil. The infiltration water collected by the cap collection system will, after confirmatory monitoring, be discharged directly to Young's Creek. As an additional environmental control measure, the containment cell liner system also includes an underdrain system that will collect any infiltrating water that passes by the cap collection system. The leachate collected by the base liner underdrain system will be piped to a collection sump. A submersible pump, equipped with an alarm monitor, will pump the

collected leachate from the sump into an underground storage tank. A vacuum truck will be required to remove and transport the leachate to the existing onsite treatment plant during its operation, and offsite if the ATP is phased out in the future.

3.5.4 Leachate Treatment

The collected leachate from the secure containment cell will be treated at the existing onsite ATP during its operation, and offsite if the ATP is phased out in the future.

3.5.5 Residue and Sludge Management

Sediment/soil captured by the perimeter silt fencing around the two staging areas will be disposed of in the onsite containment cell.

3.6 Mine Workings, Crown Pillars, and Surface Workings

There are no mine workings, crown pillars, or surface workings associated with the rehabilitation of the Young's Creek Area.

3.7 Final Site Grading

Final grade contours in the Young's Creek Area will not change significantly from existing contours with the exception of the creek areas being excavated, where elevations could decrease by up to 1.2 m, or the area of the site where the containment cell will be located. Final grade contours of the containment cell are shown in Figure 3-4. The top elevation of the containment cell will be on the order of 205 metres above sea level (masl).

3.8 Site Rehabilitation and Revegetation

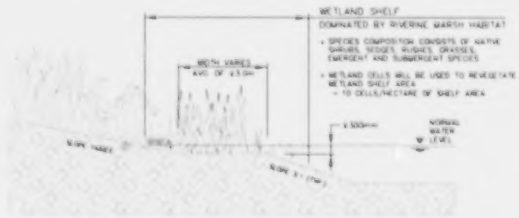
3.8.1 Creekbank and Water Courses

Following excavation of contaminated sediment and soil, grading will be carried out to provide a wetland shelf around the perimeter of the ponded areas, as shown in Figure 3-6, to re-establish the wetland environment. The shelf will be graded to provide an optimum water depth (approximately 300 mm) to support a diverse wetland community associated with the dominant riverine marsh habitat. The shelf will be continuous around the perimeter and have varying widths of +/- 3 m based on both aesthetic and MNR requirements. A 75-mm to 100-mm depth of topsoil will be required on top of the wetland shelf to provide an ideal environment for seed germination and subsequent root development. The shelf will provide limited treatment potential, but will stabilize the soil and provide an aesthetic function. The perimeter shelf will also create the hydrological conditions that will provide an ideal environment for the natural re-vegetation to occur.

CONSTRUCTED WETLAND PARCEL
DOMINATED BY RIVERINE MARSH HABITAT
• SPECIES COMPOSITION CONSISTS OF NATIVE SHRUBS, SEDGES, RUSHES, GRASSES, EMERGENT AND SUBMERGENT SPECIES
DEEP ZONE
SHALLOW EMERGENT SHELF
DEEP ZONE
PASSIVE RESTORATION WETLAND AREA
OVERFLOW STRUCTURE
NORMAL WATER LEVEL

CONSTRUCTED WETLAND PARCEL

N.T.S. 1


WETLAND SHELF
DOMINATED BY RIVERINE MARSH HABITAT
• SPECIES COMPOSITION CONSISTS OF NATIVE SHRUBS, SEDGES, RUSHES, GRASSES, EMERGENT AND SUBMERGENT SPECIES
• WETLAND CELLS WILL BE USED TO REVEGETATE WETLAND SHELF AREA
= 10 CELLS/HECTARE OF SHELF AREA
WIDTH VARIES
AVG. OF ±3.5m
NORMAL WATER LEVEL

WETLAND SHELF

N.T.S. 2

NOTES:

SCALE: 0 PEYS

Ministry of the Environment

Ontario

CH2MHILL

REHABILITATION OF THE DELORO MINE/REFINERY SITE

FIGURE 3-6 YOUNG'S CREEK AREA
SITE REHABILITATION AND REVEGETATION
PLAN VIEW AND DETAIL

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A series of wetland planting cells will be initiated at strategic locations throughout the wetland perimeter shelf. The wetland planting cell is an approximately 10-m by 10-m area, within which a specific plant mix is established that consists of seed and potted plant stock. The proposed species composition is native shrubs, sedges, rushes, grasses, and emergent/submergent species. The wetland planting cells replace the seed bed contained in the upper 500 mm of stripped soil and the substrate seed bed that was covered with 300 mm of imported soil. The proposed density is 10 planting cells per hectare of shelf area or three planting cells per kilometre of creek bank.

3.8.2 Waste Removal Areas

Two constructed wetland parcels will be located as shown in Figure 3-6 to provide water quality improvements. One wetland parcel will be located onsite at the southern extent of the remediated area just upstream of Highway 7. The offsite parcel will be located just upstream of the point of discharge into the Moira River. The wetland parcels will provide some level of treatment and filtration prior to the discharge of creek water into the Southern Pond and the Moira River.

The construction of the wetland parcels will involve placement of fill material to create the appropriate hydrological conditions to establish a shallow emergent shelf. Planting of native shrubs, sedges, rushes, grasses, and emergent/submergent species by both seed and transplanting will be completed.

3.8.3 Waste Isolation Areas

The engineered cap of the secure containment cell will be vegetated to prevent erosion and promote evapotranspiration. An infiltration water collection system will also be installed in the cap to intercept any precipitation that does not run off or is not evapotranspired. The clean, infiltrating precipitation will, after confirmatory monitoring, be directed to Young's Creek.

3.8.4 Temporary Works

Temporary works associated with the rehabilitation of the Young's Creek Area include the following:

i) Temporary Access Roads (Between Ponds)
ii) Perimeter Security Fencing (Offsite Portion of Young's Creek)
iii) Temporary Diversion Dams and Ditches
iv) Staging/Waste Conditioning Areas
v) Sedimentation Basins

Upon the completion of remediation activities in the offsite portion of Young's Creek, the owners of the properties should be consulted to determine the fate of the temporary access roads that will be constructed on their property. Depending on direction provided by the owners of the property, the access roads could either be left in place for possible continued recreational use by the owner(s), or the access roads could be revegetated and allowed to return to pre-rehabilitation conditions.

The security fencing installed around portions of the perimeter of the offsite Young's Creek Area work zone will be removed following excavation and rehabilitation activities.

When diversion dams are no longer needed in a given area, rip rap materials will be removed and stockpiled for re-use as erosion protection along the lower south and east sides of the containment cell. Inner clay core materials will be tested for contamination. If contaminant levels are low enough, clay core materials will also be stockpiled for re-use in the engineered cap of the containment cell. In the event that contaminant levels are too high to allow for re-use in the cap, clay core materials will be placed in the containment cell.

Upon completion of excavation and dewatering activities, the compacted granular A used to construct the staging areas will be placed in the containment cell. The crushed stone will be removed and stockpiled for future use onsite.

Once contaminated sediment and soil have been removed, sediment that have accumulated in the sedimentation basins will be tested and, if necessary, transferred to the onsite containment cell. Imported fill material will not be needed to fill in the sedimentation basins. The sedimentation basins will then be used to create the two wetland parcels as discussed in Section 3.8.2.

4. Implementation Plan

4.1 Identification of Work Packages

Rehabilitation efforts in the Young's Creek Area have been divided into five distinct work packages. The work packages listed below have been assembled such that each work package could be contracted out and constructed independently of the other work packages. Alternatively, the work packages identified below could be combined to reduce the number of contracted work packages:

YC-WP#1 Containment Cell Liner System Construction

a) Phase 1
b) Phase 2

YC-WP#2 Onsite Contaminated Sediment and Soil Excavation, Dewatering, and Placement in Containment Cell

a) Staging Area Construction
b) Sedimentation Basin
c) Temporary Diversion Dams
d) Western Portion Excavation
e) Eastern Portion Excavation
f) Cap Construction

YC-WP#3 Onsite Creek Rehabilitation

a) Constructed Wetland Parcel
b) Perimeter Wetland Shelf
c) Wetland Planting Cells

YC-WP#4 Offsite Contaminated Sediment Excavation, Dewatering, and Placement in Containment Cell

a) Staging Area Construction
b) Sedimentation Basin
c) Temporary Diversion Dams
d) Northern Pond
e) Central Pond
f) Southern Pond
g) Cap Construction

YC-WP#5 Offsite Creek Rehabilitation

a) Constructed Wetland Parcel
b) Perimeter Wetland Shelf
c) Wetland Planting Cells

4.2 Sequencing of Work Packages

In general, the work packages listed above would be completed in the order listed above. The opportunity also exists for some of the work packages to be completed concurrently as discussed later in Section 4 under Implementation Schedule. It would be preferable, from a coordination standpoint, to have the same contractor construct the containment cell liner system (YC-WP#1) as well as complete the onsite (YC-WP#2) and offsite (YC-WP#4) excavation and placement of contaminated sediment/soil. This would help to eliminate possible problems in coordination that could result if multiple contractors were used.

Initially, the containment cell liner system (YC-WP#1) needs to be constructed prior to excavation and transfer of contaminated sediment/soil. This work will include the clearing and grubbing of the proposed containment cell location, rock blasting, subgrade preparation, and liner system installation. The liner system would be completed in two phases since the full containment cell encroaches and extends out into the Young's Creek Basin where contaminated sediment are present. These contaminated sediment require excavation prior to installing the portion of the containment cell liner system that extends into the creek basin. The first phase would consist of installing the western portion of the liner system, which is the portion that is not in the current creek basin. Upon excavation of contaminated sediment in the northwest sector of the onsite portion of Young's Creek (YC-WP#2), the second phase of the liner system would be installed.

Once the containment cell liner system is in place, contaminated sediment/soil excavation, transport, dewatering and storage can commence. It is recommended that the onsite portion of Young's Creek be completed (YC-WP#2) before the offsite portion of Young's Creek and in general, excavation should proceed in an upstream to downstream order. Proceeding in this manner will prevent the possibility of recontaminating cleaned areas through redeposition of contaminated sediment. The onsite excavation will begin in the northwest sector in order to remove contaminated sediment/soil from the footprint of the containment cell. Once contaminated sediment/soil are removed from the northwest sector, the Phase 2 containment cell liner system construction can be completed.

It is anticipated that the containment cell cap system will be constructed progressively/concurrently as the sediment and soil are being placed in the cell. Proceeding in this manner will minimize exposure of consolidated sediment and soil to the environment. Leachate generation and contaminated surface water runoff will thus be minimized during the construction phase.

After the contaminated sediment and soil have been removed from the onsite portion of Young's Creek, onsite creek rehabilitation activities can be completed (YC-WP#3) that include a constructed wetland parcel adjacent to the Highway 7 outflow, creation of a perimeter wetland shelf with planting cells, and installation of wetland planting cells.

Concurrent with or subsequent to onsite creek rehabilitation activities, excavation and transfer of contaminated sediment in the offsite portion of Young's Creek can be completed (YC-WP#4). Excavation in the offsite portion will occur in the downstream direction beginning with the Northern Pond and ending with the section of Young's Creek just prior to confluence with the Moira River.

Once contaminated sediment have been removed from the various ponds in the offsite portion of Young's Creek, offsite creek rehabilitation activities as described previously can be completed (YC-WP#5).

4.3 Anticipated Construction Impacts and Mitigation Measures

Anticipated construction impacts include the following:

i) Disruption During Fish Spawning Periods
ii) Suspended Sediment in Surface Water
iii) Suspended Particulates in Air
iv) Removal of Vegetation to Create Temporary Access Roads
v) Removal of Vegetation and Rock Blasting to Prepare Site for Containment Cell

Mitigation measures to address each of these anticipated impacts are discussed below.

To eliminate disruption during fish spawning periods, restrictions in the timing of remedial activities would be applied. It is anticipated that the restriction periods would be determined in consultation with the MNR and the Moira River Conservation Authority (MRCA) care of QC. These restriction periods would be stated on permits or approvals issued by these Regulatory Agencies.

To eliminate/minimize suspended sediment concentrations during work in the Young's Creek Area, diversion dams and/or ditches will be used to isolate surface water flows from active excavation areas. At no time will excavation be allowed in an area of active surface water flow. As an added mitigation measure, sedimentation basins will be created at the southern end of the onsite portion of Young's Creek adjacent to the Highway 7 culvert and at the southern extent of the Southern Pond. These basins will allow suspended sediment to settle, prior to discharging to the Moira River. The basins will be sized to allow sedimentation of suspended sediment, such that water quality released from the basins will be consistent with ambient water quality within the Young's Creek Area and the Moira River. As outlined in Section 6, periodic testing of water quality for arsenic, metals of concern, and total suspended solids will be conducted during remedial activities. The results will be compared to ambient water quality in Young's Creek and the Moira River and also compared to the PWQO. If water quality is consistent with that of ambient conditions in the Young's Creek Area and the Moira River, no additional protective measures will be implemented. If water quality is worse than ambient conditions in the Young's Creek Area and the Moira River, additional mitigative measures will be considered as appropriate. As discussed in Section 3.3.4, silt control fencing will be placed around the perimeter of the staging areas to prevent silt runoff into the creek. Runoff from the staging areas will discharge to the creek and eventually to the sedimentation basins, where any residual suspended sediment will be allowed to settle.

During the removal of sediment from the short stretch of Young's Creek between Old Marmora Road and the Moira River, geotextile silt fencing will be used in conjunction with sand bags and/or straw bales to minimize suspended sediment transport to the Moira River.

The excavation and transport of wet sediment and soil from the onsite and offsite portions of Young's Creek will not present a suspended particulates hazard; however, during the dewatering and transfer to the containment cell, dust suppression will be used as necessary to ensure acceptable concentrations of suspended particulates in the air.

Removal of vegetative cover, brush and trees will be required to create the temporary access and haul roads in the offsite portion of Young's Creek. To minimize the impact of clearing activities, access road alignments will be selected that utilize the existing floodplain as much as possible and minimize the cutting of trees larger than 100 mm in diameter. Depending on direction provided by the property owners of the offsite portion of Young's Creek, replanting of native species along the access road corridor could be undertaken after contaminated sediment have been removed.

Rock blasting will be required to prepare the sub-grade for the liner system for the proposed containment cell. The containment cell area is located approximately 185 m downstream of both the west and east tailings dam walls.

SRK Consulting (SRK) has undertaken a preliminary assessment of the affect of shallow rock blasting on the stability of the west and east tailings dam walls in the report entitled, *East and West Stability Assessment and Conceptual Remediation Measures, Red Mud Tailings Impoundment, Deloro Mine Site, Ontario, Canada, Revised Draft #002* (SRK, May 2004). SRK stated in its report that in their professional opinion, "blasting of a shallow sump 185 m from each wall would not affect the dam walls stability; however, prior to undertaking any such blasting a suitably qualified blasting contractor should be approached to discuss a suitable blasting pattern and the associated peak ground accelerations. That information can be used to establish, based on general rules of thumb, what would be the best way to proceed. Suitable time spaced small single blasts would likely be the safest solution. In any event it would be the prudent approach to start with small blasts and monitor the impact through the use of appropriate instrumentation at each wall."

SRK also recommended that the engineered soil cover over the Tailings Area be continued over the dam crest, over the existing buttress, and to natural ground downstream of the buttress. This approach will enhance dam stability and if completed prior to conducting the blasting for the Young's Creek containment cell, such buttressing will further safeguard the tailings dam walls. CH2M HILL has incorporated this feature of the cover design in the report entitled, *Deloro Mine Site Cleanup – Tailings Area Closure Plan, Draft Report* (CH2M HILL, March 2004).

Rock blasting will be performed in accordance with the applicable regulations. Standard blasting precautions will be taken that include the use of blasting mats. In addition, the final design specifications for the blasting work will require a blasting plan to be developed that will address the effect of the blasting work on the stability of the tailings dam walls. The blasting plan will evaluate the potential impact of blasting on stability of the dam walls, stipulate the details of stability monitoring of the dam walls during blasting, and state restrictions on blasting depths.

4.4 Implementation Schedule

An implementation schedule for the five work packages is shown in Figure 4-1. The schedule shows potential start and end periods for each work package, as well as the expected time required to complete each work package. Following the critical path, it is estimated that the amount of time required to rehabilitate the Young's Creek Area will be approximately four years.

Figure 4-1
Proposed Project Schedule

Deloro Mine Site Cleanup, Young's Creek Area Rehabilitation Closure Plan Implementation

Ministry of the Environment
Ontario

CH2MHILL

		Year 1				Year 2				Year 3				Year 4			
Work Package ID Number	**Description**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**	**Winter**	**Spring**	**Summer**	**Fall**
	Project Initiation																
YC-WP#1	**Containment Cell Liner System Construction**																
	a) Phase 1																
	b) Phase 2																
YC-WP#2	**Onsite Contaminated Sediment and Soil Excavation, Dewatering, and Placement in Containment Cell**																
	a) Staging Area Construction																
	b) Sedimentation Basin																
	c) Temporary Diversion Dams																
	d) Western Portion Excavation																
	e) Eastern Portion Excavation																
	f) Cap Construction																
YC-WP#3	**Onsite Creek Rehabilitation**																
	a) Constructed Wetland Parcel																
	b) Perimeter Wetland Shelf																
	c) Wetland Planting Cells																
YC-WP#4	**Offsite Contaminated Sediment Excavation, Dewatering, and Placement in Containment Cell**																
	a) Staging Area Construction																
	b) Sedimentation Basin																
	c) Temporary Diversion Dams																
	d) Northern Pond																
	e) Central Pond																
	f) Southern Pond																
	g) Cap Construction																
YC-WP#5	**Offsite Creek Rehabilitation**																
	a) Constructed Wetland Parcel																
	b) Perimeter Wetland Shelf																
	c) Wetland Planting Cells																

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A start date has not been prescribed since it is recognized that the estimated start date will be developed in the integrated site-wide cleanup plan. The integrated cleanup plan will prioritize site-wide rehabilitation work packages based on the ability of an individual work package to lower contaminant loading rates, and reduce public health and environmental hazards, as well as consider budgetary constraints. The schedule provided in Figure 4-1 will be used to develop an overall site-wide implementation schedule.

4.5 Cost Opinion for Work Packages

The costs required to implement the recommended rehabilitation alternative for the Young's Creek Area of the Deloro site have been developed previously in the report entitled *Deloro Mine Site Cleanup – Young's Creek Area Rehabilitation Alternatives, Final Report* (CH2M HILL, May 2003). These costs were used as a basis to develop the updated costs in Table 4.1 for the Young's Creek Area Closure Plan. The updated costs in Table 4.1 take into consideration the following information and data which has become available since the alternatives report was finalized in May 2003:

- Increase of 8,000 m^3 of contaminated sediment in the offsite portion of Young's Creek as determined in the SSRA work. Cost increase of approximately $350,000 for excavation, transportation and increased capacity of onsite containment cell.
- Significant preparation work such as blasting, blast monitoring to assess stability of tailings dam walls, and imported engineered fill required for the containment cell liner system as determined during the July 2003 geotechnical investigation. Cost increase of approximately $3,500,000.
- Suitable clay for containment cell liner and cap systems has not been confirmed locally. It has conservatively been assumed that clay will have to be imported from a non-local source. Cost increase of approximately $1,750,000.
- Leachate piping system to the ATP has been replaced by a holding tank that will be pumped out as required. Cost decrease of approximately $800,000.
- OMM costs have been refined to coincide with a defined scope of work that is outlined in Section 5. Cost decrease of approximately $23,500 per year or a total decrease of $185,000 for the selected 20-year period.

The net result is that the total cost to implement the recommended rehabilitation alternative has increased by approximately $4,400,000 from the previous cost estimate in the Alternatives Report (i.e. from $12,487,000 to $16,873,000). Since the containment cell was a common item in the alternatives evaluated in the alternatives report, this increase in cost does not change the outcome of the alternative selected. It is noted that the cost of the containment cell is approximately $10.6 million. The unit cost to place the contaminated sediment and soil in the containment cell is therefore approximately $40/$m^3$ or $22/tonne which is significantly less than typical offsite disposal costs for hazardous waste or disposal tipping fees for contaminated soil.

TABLE 4.1
COST SUMMARY TO IMPLEMENT RECOMMENDED REMEDIATION ALTERNATIVE AND COMPLETE REQUIRED WORK PACKAGES

Young's Creek Area Closure Plan

Work Package Identification Number	Description	Estimated Cost * (2004 dollars)
Capital Cost Items		
YC-WP#1	Containment Cell Liner System Construction	$7,035,000
YC-WP#2	Onsite Contaminated Sediment and Soil Excavation, Dewatering, and Placement in Containment Cell (includes cap construction)	$5,600,000
YC-WP#3	Onsite Creek Rehabilitation	$350,000
YC-WP#4	Offsite Contaminated Sediment Excavation, Dewatering, and Placement in Containment Cell (includes cap construction)	$3,538,000
YC-WP#5	Offsite Creek Rehabilitation	$350,000
Total Capital Costs		**$16,873,000**
Operation, Maintenance, and Monitoring Cost Items (Average Weighted Annual Costs)		
Total Average Weighted Annual OMM Cost**		**$41,508**
NPV OMM Costs		**$665,000*****
NPV of Capital and OMM Costs		**$17,538,000**

* All costs have been developed using 2004 pricing and do not include an escalation factor.
** Includes removal of leachate from holding tank, monitoring program, and maintenance of containment cell and wetlands.
***NPV of average weighted annual OMM costs using an effective interest rate of 5 percent and a planning horizon of 20 years.

The net present value (NPV) costs presented above are the sum of the capital cost and the net present value of the OMM costs. The annual OMM costs have been transformed to a net present value assuming an effective interest rate of 5 percent and a planning horizon of 20 years. The effective interest rate includes inflationary effects. It should be noted that OMM effort and costs will be required beyond the 20-year horizon. The 20-year period was selected based on the assumption that it is a reasonable period for budgetary planning purposes.

The total estimated cost to clean up and rehabilitate the Young's Creek Area (Onsite and Offsite portions) is $16,873,000 in 2004 dollars with average weighted annual OMM costs of $41,508. The NPV of this remediation work, assuming an effective interest rate of 5 percent and a planning horizon of 20 years, is $17, 538,000. The capital costs presented in Table 4.1 include overhead, remote location costs, the federal Goods and Services Tax (GST), a 15 percent contingency, and the cost of various construction bonds and insurance associated with the work. The costs presented are expected to have an accuracy on the order of +/-25 percent. A breakdown of the estimated costs is provided in Appendix A. The major assumptions used in making this cost estimate are also provided in Appendix A. The costing in Appendix A has been completed at the preliminary design level and should be considered as a "cost opinion" to assist in budgeting. An appropriate allowance should be included in any budget planning to account for cost escalation above 2004 dollars. Costs can further be refined once the recommended alternative has been accepted and the detailed design and approach have been finalized.

4.6 Health Hazard Assessment

A document entitled *Deloro Mine Rehabilitation Project – General Health and Safety Plan (GHASP), Final Report* (CH2M HILL, January 2002) has been developed to identify the main hazards and to provide a basis for the health and safety protocols. This report was updated in April 2003.

The GHASP identifies the following health hazards associated with the Deloro Mine Site, that could be encountered while undertaking site inspections, site investigations, and remedial cleanup:

- Arsenic and arsenic compounds, other metals, and silica
- Radiological hazards
- Heat and cold stress
- Buried utilities
- General physical (safety) hazards
- Biological hazards
- Chemicals existing at or brought onto site

The GHASP outlines and describes appropriate procedures and protocols to effectively deal with the above hazards associated with the Deloro Mine Site. The GHASP addresses: hazard evaluation and control procedures and protocols (including action levels), personal protective equipment to be used, air monitoring protocols and specifications, decontamination procedures and protocols, spill containment procedures, confined space entry procedures, emergency response plan, and emergency contacts.

Addenda will be added to the GHASP to address specific work packages identified in this and the other three Closure Plans.

Radiological hazards result from radioactive slag, some tailings-like material in the Industrial Area and sediment in the onsite Young's Creek Area contaminated by radium and uranium tailings eroded from the Tailings Area. The slag represents an external hazard from radiation fields, whereas the tailings-like materials and sediment represent both external hazards due to radiation fields and internal hazards from potential ingestion and/or inhalation during the handling activities. Although ambient radiation fields in most of the work areas are expected to be below 1 μSv/h, standard radiation protection procedures as described in the GHASP will be employed to minimize doses to workers during the various remediation activities. Routine radiation field monitoring will be used to identify those areas in which radiation protection procedures must be implemented. Contamination control procedures will also be implemented as described in the GHASP. Decontamination procedures are outlined in Section 4.7.4 of this Closure Plan.

4.7 Environmental and Community Health Protection Plan

Potential receptors that could be affected by the cleanup of the Deloro Mine Site include workers involved in the site cleanup, residents in the Village of Deloro, residents and cottagers along the Moira River downstream of the site, and vehicular traffic along Highway 7 near Young's Creek (in the case of impacted materials to be transported onsite

from offsite Young's Creek across Highway 7). The following Environmental and Community Health Protection Plan (ECHPP) identifies potential risks associated with the cleanup of the Deloro site and recommends appropriate mitigation measures. Protection of workers involved in the site cleanup was addressed in Section 4.6. Specific mitigation measures arising from anticipated construction impacts and malfunctions/accidents during the remediation of Young's Creek are addressed in Section 4.3 and 7, respectively.

The disturbance of potentially contaminated materials during remedial activities and the possible loss of contaminants from the work area depends to a high degree on the remedial methods and related physical activities undertaken during site rehabilitation. Since the transport of contaminants is most easily controlled at the source, the remedial activities selected for the site have been chosen based on the ability to minimize and control the disturbance, spread and loss of contaminants from the work area. Additional actions can be taken to further limit the spread and loss of contaminants from the work area and potentially offsite. These include measures to control dust, noise, odours, surface water runoff, surface water run-on and erosion, as well as the use of appropriate equipment and personnel decontamination procedures. Each of these measures, which are discussed briefly below, will be undertaken prior to and during implementation of the remedial activities. Odour control is not discussed since it is not expected to be of concern during implementation of remedial activities at the Deloro site.

It should be noted that this overview provides some of the key aspects associated with the mitigation and monitoring of potential offsite impacts resulting from remedial activities at the Deloro site. The specific details and procedures will be included in the contract documents and specifications associated with the rehabilitation of the Deloro site, and the execution plans proposed by the remedial contractors who are selected to complete the cleanup work.

4.7.1 Dust Control and Air Monitoring

Effective dust control at sites undergoing remediation is best addressed via the development, establishment, implementation and enforcement of a fugitive particulate emission control program. The development and implementation of such a program is generally the responsibility of the remedial contractor and is required to be reviewed and approved by the owner and/or the consultant. The fugitive particulate emission control program includes a description of the procedures relating to the handling of materials, air monitoring and dust control, and is documented in the contractor's execution plan for the site remedial activities. The remedial contractor is required to take all precautions necessary to minimize and control the generation of dust and under no circumstances will unacceptable levels of dust be permitted to be generated and/or transported offsite.

Key aspects of a fugitive particulate emission control program include:

- Carrying out remedial activities that involve disturbance of material, such as excavation, during good weather conditions in order to minimize the loss of materials by wind.
- Movement of materials directly to their designated location, rather than handling several times, in order to minimize the generation of dust (i.e. multiple handling tends to break materials into smaller and smaller pieces which are more likely to be entrained by wind).

- Ensuring adequate equipment and personnel are available at the site at all times to immediately clean up any spilled material, whether it be of a small or large amount.
- An inspection program to monitor the condition of onsite and offsite roads, materials piles, vehicles, etc.
- The use of tarps to cover materials which are likely to generate dust.
- The use of dust suppressants to control dust associated with roadways, work areas, stockpiles and other possible sources. Materials used to assist in dust suppression might include water, calcium chloride or latex binders. The frequency of application of dust suppressants is generally on an as-needed basis.
- Regrading of unpaved roads, as required, to keep silt content below 10 percent, and the sweeping of paved roads.
- The use of tarps on trucks used to transport materials onsite and offsite.
- In the case of the Deloro site cleanup, air monitoring both upwind and downwind of the site will be carried out in order to confirm that dust control measures are effective, and to ensure that any potential offsite air quality impacts caused by remedial operations are minimized. Monitoring should be carried out for dustfall and total suspended particulate matter (TSP). Monitoring for arsenic and other selected metals should also be considered. Although in the handling of radioactive tailings, radioactive contaminants may become airborne, the expected levels will be considerably less restrictive than those for arsenic at similar TSP concentrations.
- The frequency of monitoring and location of monitoring stations at the Deloro site will be determined following the development of the final integrated cleanup plan, and the review of the contractor's execution plan, the proposed remedial activities and meteorological conditions. Typically, TSP is measured using standard high-volume samplers and a daily (24-hour) average determined. Depending on the size of the site, samplers are typically located at four upwind/downwind perimeter sites during each work day. Their location is subject to change based on the location of remedial activities, but they are generally placed at the furthest possible distance downwind of the site within the property line. Standard dustfall jars are used to obtain dustfall measurements, which are typically determined based on a 30-day integrated measurement of dustfall loadings at four perimeter locations.
- Meteorological measurements (wind speed and direction) may also be required to be carried out in conjunction with the air monitoring program. Typically, hourly and daily average wind speed and direction at one localized site could be required during site activities.
- The MOE Ambient Air Quality Criteria (AAQC) for dustfall is 7 g/m^2 (30-day AAQC) and for TSP is 120 $\mu g/m^3$ (24-hr AAQC). The AAQC for TSP and dustfall were determined with nuisance effects being the limiting factor. Health effects are not a concern until TSP levels are several times higher than defined by the AAQC, unless elevated concentrations of arsenic and/or other metals are present in the dust. Levels in excess of these criteria, on the basis of property line monitoring results, are considered unacceptable. In instances where background or upwind concentrations exceed these

criteria, additional contribution to the parameter is also normally considered unacceptable.

- Monitoring of ambient air quality prior to initiation of remedial activities at the Deloro site is recommended and should be carried out on several occasions and under a variety of conditions in order to establish background air quality both onsite and offsite.

4.7.2 Noise Control

While noise is expected to be generated at the Deloro site during cleanup as a result of mobile sources such as truck and vehicular traffic, as well as equipment sources such as excavators, bulldozers, compactors, generators, pumps and air compressors, conformation with regulatory requirements is not expected to be a major problem. The development and implementation of a noise monitoring and control program is generally the responsibility of the remedial contractor and is required to be reviewed and approved by the owner and/or the consultant prior to initiation of any site work. The contractor is usually required to provide written details of the noise monitoring and control program in the execution plan to ensure that local requirements are met.

Typical aspects of a noise monitoring and control program include:

- The contractor will be required to take all precautions necessary to minimize noise and under no circumstances will unacceptable levels of noise be permitted to impact offsite residents/property owners.
- The contractor is to conduct all work using appropriate construction methods and equipment so that noise emanating from the site remains at acceptable levels.
- The contractor is required to obtain approval from the owner and/or consultant prior to conducting any site activities between the hours of 6:00 p.m. and 7:00 a.m.
- The contractor will be required to undertake noise monitoring if deemed necessary.
- MOE noise guidelines for landfill operations suggest that a criterion of 50 dBA during the hours of 7:00 a.m. and 7:00 p.m. should be established for the closest residential location. A similar guideline may be suitable for the cleanup activities at the Deloro site.

4.7.3 Surface Water Protection

The control of surface water is required in order to minimize the contact of water with potentially contaminated materials and thus reduce the generation of contaminated water. This can be achieved though the control of surface water runoff from the work area, as well as the control of surface water run-on into the work area. Surface water is also required to be controlled in order to minimize erosion and prevent the offsite transport of potentially contaminated water and sediment to Young's Creek and the Moira River. Specific details relating to the control and protection of surface water in the Young's Creek Area are addressed in previous sections.

The development and implementation of a work area surface water control program is generally the responsibility of the remedial contractor and is required to be reviewed and approved by the owner and/or the consultant. Generally, the remedial contractor is required

to take all precautions necessary to minimize the generation of sediment and potentially contaminated surface water and may be required to collect and treat any such water.

Key aspects of a work area surface water control program include:

- The use of geotextile silt fencing, sand bags and/or straw bales to reduce sediment transport.
- The construction of surface water diversions, comprised of swales and sumps or clay berms, to re-direct and/or collect surface water runoff and run-on.
- The collection and treatment of all potentially contaminated water, including water used to decontaminate equipment, surface water and water generated from the dewatering of excavations.
- In the case of the Deloro site cleanup, surface runoff characteristics (i.e. quantity, quality and direction of flow) of the site should be assessed prior to initiation of remedial activities. Additionally, an assessment of the quality of water in existing site drainage ditches and channels, including those that result in both runon and runoff, standing water and natural water (i.e. any adjacent natural streams, wetland areas, and the Moira River) should be undertaken prior to remedial activities (if not addressed through current site monitoring). The water quality assessment should include the sampling and analysis of water for total suspended solids, arsenic, and metals.
- Once a decision on the activities planned for the Deloro site is made, a site-wide surface water quality monitoring program should be developed for implementation during the cleanup.

4.7.4 Decontamination Procedures

In order to prevent the transfer of contaminants from the work area, all equipment, materials, and supplies that come into contact with potentially contaminated materials must be decontaminated prior to removal from the work area. The development and implementation of equipment decontamination procedures is generally the responsibility of the remedial contractor and is required to be reviewed and approved by the owner and/or the consultant. The remedial contractor is required to take all precautions necessary to minimize the transfer of contaminated materials from the work area. Under no circumstances is the transfer of non-decontaminated equipment and materials from the work area permitted.

The key aspects of a decontamination program include:

- Decontamination of equipment and materials that have come into contact with potentially contaminated materials, completed by the contractor prior to the removal of equipment and materials from the work area.
- Equipment decontamination using water or steam facilities to decontaminate tracks, sprockets, tires, axles, buckets, and trailers used in the transport of materials.
- Instrumentation used to confirm the effectiveness of decontamination procedures. In the Industrial Area and the Young's Creek Area (onsite), radioactive contamination is ubiquitous and readily detectable with a radiation detector and therefore can serve as an indicator for the presence of other (e.g. arsenic) contamination.

An equipment washdown facility to address contamination issues for vehicles leaving the Deloro Mine Site is planned for construction in the Industrial Area. Wastewater from this decontamination facility will be directed to the ATP for treatment. A Certificate of Approval (C of A) has been received for this facility.

4.7.5 Control Measures for the Transport of Contaminated Sediment Across Highway 7

Contaminated sediment from the offsite portion of Young's Creek will require transport across Highway 7 to the secure onsite containment cell. It is proposed that trucks will make a perpendicular crossing of Highway 7 from the offsite portion of Young's Creek to the existing access road located adjacent to the west side of the onsite portion of Young's Creek, as shown in Figure 3-2. Control measures are required during the crossing of Highway 7 to address the following concerns:

- Traffic Control
- Tracking of Soil/Sediment onto Highway 7
- Accidental Spills

With respect to traffic control, safety measures will include the use of signs to caution the public along Highway 7 and at site entrances. Signage may include *"Trucks Turning"* and other construction warning signs on Highway 7, as well as *"Danger – Access By Permit Only"* at access gates. Additionally, flagmen will be used as needed along Highway 7 during busy traffic periods to control traffic while haul trucks cross Highway 7 to enter the access road that runs along the western side of the Young's Creek Basin. Due to the relatively light traffic density along Highway 7 in the vicinity of the site, permanent traffic controls are not likely warranted and traffic flow disruptions are anticipated to be relatively minimal.

Prior to leaving the work area, haul trucks will be cleaned in accordance with a decontamination plan that will be established and approved before excavation work begins as described in the previous section. In brief, wet soil/sediment that adheres to truck tires or truck bodies and undercarriages will be removed at a decontamination pad located in the Young's Creek Area prior to entering the Highway 7 right-of-way. Decontamination will consist of the removal of all loose materials, generally by sweeping and wiping of the surfaces. If more vigorous cleaning is required, high-pressure water washing and/or steam will be used. All vehicles and equipment exposed to potentially contaminated material will be stored within the secured area of the site overnight and on weekends unless monitored, decontaminated and approved for release. All equipment involved in the excavation, handling and transportation of contaminated soil, including the haul trucks, will be dedicated to the project until released after monitoring and decontamination (if necessary) to assure levels of radioactivity are not discernable from that of local background.

CH2M HILL will develop a site-specific emergency procedures plan including procedures, requirements and information relating to emergency contacts, directions to the nearest hospital, spill and fire control, emergency communications, emergency response such as for a spill or fire, medical emergency, notification, and reporting. All site contractors will be expected to be familiar with and implement the site-specific emergency procedures plan as required. Much of this information is already contained in the GHASP (CH2M HILL, January 2002).

CH2M HILL will develop a site Transportation and Emergency Response Plan (TERP) to outline procedures and protocols for addressing the potential for vehicular accidents and spills of hazardous and non-hazardous materials. Elements of the TERP are discussed below.

Procedural controls will limit the speed of vehicles and determine safe routes. If a project haul truck has a tire failure, a mechanical breakdown, or is involved in a minor collision where no injury or no loss of the truck payload occurs, the driver will immediately radio or telephone the contractor's Superintendent to summon the appropriate assistance (i.e. police, tire truck, mechanic, etc.). The Superintendent will immediately inform the Engineer who will, in turn, advise the MOE of this occurrence. If a haul truck requires mechanical repairs at any location beyond the secured area of the site, or off the haul route, the truck will be towed to the secure containment cell for unloading (if required), completely cleaned of soil, monitored and released from the site for the necessary repairs. In case of a collision where injury has occurred, the driver (if not injured) will first contact the appropriate emergency response personnel (i.e. ambulance, police, etc.) and then the contractor's Superintendent. Subsequently, the Engineer will be informed and, in turn, the MOE.

If a project haul truck has a tire failure, a mechanical breakdown, or is involved in a minor collision where loss of the truck payload occurs, the appropriate assistance (i.e. police, tire truck, mechanic, etc.) will be summoned. In the case of an upset or an unexpected release (i.e. spill) of soil, the contractor will have emergency barricades, flagging personnel, and cleanup equipment available to promptly implement a cleanup. In the event that heavy rain occurs during the incident, ditches and/or berms will be immediately constructed to prevent further spread of spilled materials. Specifically, the cleanup will consist of the following measures:

- Access to the area will be controlled.
- Personal protective equipment appropriate for all soil handling to be worn (i.e. safety boots, cloth coveralls, gloves, eye protection, hard hats).
- The area will be cleaned and the spilled soil re-loaded on a replacement vehicle with a loader, brooms and shovels, etc.
- Spill areas and all equipment used will be monitored with radiation detection equipment to ensure that residual levels are not discernable from that of local background.

4.7.6 Associated Considerations and Activities

Several issues associated with the mitigation of offsite impacts include:

- As noted, a TERP will be prepared to address the potential for vehicular accidents and spills of hazardous and non-hazardous materials.
- The development and implementation of specific work practices associated with contaminated, decontaminated, and clean work zones.
- In addition to the existing perimeter fencing, the development and implementation of a site security plan including aspects such as additional fencing of work areas, warning/caution signs, security patrols, control of site staff and visitors, etc.

- The use of a qualified environmental contractor who is experienced in similar types of projects, has a good safety and environmental record, and whose employees are experienced and qualified.

4.8 Other Operational Procedures

Other operational procedures are associated with the operation of the onsite ATP. As detailed in Section 3, leachate collected from the secure containment cell will be collected and transferred to the onsite ATP. The operational procedures associated with the ATP are contained in the Industrial Area Closure Plan.

5. Operation and Maintenance Requirements

Operation and maintenance efforts under this alternative will be associated primarily with the onsite secure containment cell. Ongoing maintenance of the engineered cap will be required to repair any erosion damage. The constructed wetland parcels and perimeter wetland shelf should be monitored as specified in Section 6 to ensure plant growth has been well established. Replanting of dead plant material may be required.

The leachate collection system is intended to act as a secondary containment measure for the cap system. Under normal operating conditions, little or no leachate is expected to be collected. Any leachate that is collected will be directed from the collection sump(s) to an underground storage tank adjacent to the secure containment cell. The tank could be equipped with a level monitoring device indicating when emptying is required. The leachate collected in the tank would be tested, pumped out by a vacuum truck, and transported to the onsite ATP for treatment.

The treatment costs associated with the leachate collected from the containment cell have been included in the Industrial Area costs. These costs have not been duplicated in this evaluation. It is anticipated that the volume of leachate requiring treatment from the Young's Creek Area containment cell will be small relative to the capacity of the treatment plant (<1 percent). If the onsite ATP is phased out in the future, removal of any leachate collected in the leachate collection system and transport to an offsite treatment facility will be required.

A detailed operations and maintenance plan should be established for the containment cell following implementation of this alternative.

In addition, as part of a site-wide maintenance activity, the perimeter fence should be inspected semi-annually in the spring and fall, and repairs should be undertaken as required. The MNR should be contacted in the event large mammals become trapped inside the perimeter fence, to determine a suitable course of action.

6. Monitoring Program

The monitoring program recommended for the Young's Creek Area is briefly summarized in Table 6.1. The monitoring program stipulates monitoring requirements during the shorter-term rehabilitation stage as well for the longer-term post-closure stage.

TABLE 6.1
YOUNG'S CREEK AREA CLOSURE PLAN PROPOSED ENVIRONMENTAL MONITORING PLAN

Type of Monitoring	Description	Duration	Frequency
Physical Stability	Visual inspection of vegetative cover, erosion problems, tension cracks, seeps	Indefinitely following containment cell capping	Semi-annual for Years 0-3 Annual after Year 3
Water Quality	Sampling and analysis of surface water at key selected locations	During the excavation stage of the project	Weekly during excavation
Water Quality	Sampling and analysis of surface water at key selected locations	Indefinitely following containment cell capping	Semi-annual for Years 0 to 5 Annual after Year 5
Leachate Quality	Sampling and analysis of leachate at collection sump	Indefinitely following containment cell capping	Semi-annual for Years 0 to 5 Annual after Year 5
Sediment and Soil Quality	Confirmatory sampling and analysis of excavation floor	During the excavation stage of the project	30 m by 30 m grid
Biomonitoring	Refer to biomonitoring section below	Indefinitely	Annually for years 0 to 5 Once every 5 years for the next 20 years Once every 10 years thereafter
Influent/Effluent Quality	Sampling and analysis of influent/effluent from ATP	Refer to closure plan for the Industrial Area	Refer to closure plan for the Industrial Area

Following completion of rehabilitation activities, the results of monitoring during closure activities should be documented in a Closure Report. During the post-closure period, annual reports should be prepared that document the results of monitoring activities for that year. The various components associated with the monitoring program are described in detail below.

6.1 Physical Stability

Long-term monitoring of the physical stability of the secure containment cell will be required following installation of the cap system. Physical monitoring of the engineered cap

is required to identify surface water erosion damage, vegetative stress, tension cracks at the crest of slopes, or seepage along the side slopes. Semi-annual physical stability monitoring is recommended for the first three years after the containment cell vegetative cover has been planted. Once the cap's vegetative cover has become well established, annual monitoring is recommended. Periodic radiation field surveys (i.e. once every five years or upon discovery of a substantial crack) should be conducted as a further check of the integrity of the cap.

6.2 Chemical Stability and Water Quality

During the rehabilitation stage, monitoring will be required for surface water and sediment quality. Surface water sampling and analysis is required to assess the impacts or surface water quality during excavation activities. The purpose of the surface water quality monitoring will be to assess the success of surface water quality protective measures that have been taken during excavation activities. During periods of active excavation work onsite, surface water samples should be collected on a weekly basis and analyzed for arsenic, metals of concern, and suspended solids. The water samples should be collected at the entrance to the culvert that lies under Highway 7. During periods of active excavation in the offsite portion of Young's Creek, surface water samples should be collected at the point where the pond being excavated drains, and analyzed for arsenic, metals of concern, and suspended sediment. The results should be compared to historical pre-excavation concentrations from the current OCWA monitoring program as well as to the MOE's PWQOs (MOEE, 1994).

Confirmatory monitoring of sediment or soil quality will be required following excavation activities to confirm that remaining sediment meet the MOE Severe Effect Level (SEL) criteria or applicable criteria developed as part of the SSRA for the site. It is anticipated that following remediation, the sediment/soil quality will be similar to the ambient sediment quality in the Moira River, Moira Lake, and Stoco Lake as noted in Section 3.3.3.

A grid-based monitoring technique will be used to determine sample locations. A grid spacing of 30 m by 30 m is suggested, which would result in a total of approximately 500 confirmatory samples throughout the Young's Creek Basin. Samples would be analyzed for arsenic and metals of concern including cobalt, copper, nickel, and uranium. Further excavation will be required in areas where confirmatory sample concentrations exceed the closure criteria. Additional confirmatory sampling will be required in areas of further excavation. In addition to confirmatory sampling for arsenic and metals, the final excavation floor surface will be monitored for the presence of radionuclides, as appropriate.

Water quality monitoring during the post-closure stage (i.e. following placement of the engineered cap on the secure containment cell), will consist of sampling and analysis of the liquid collected by the leachate collection system and of surface water collected in Young's Creek immediately downstream of the containment cell, at the creek exit under Highway 7, and at the confluence with the Moira River. The purpose of this monitoring will be to assess the success of rehabilitation efforts on improving the surface water quality in the Young's Creek Basin, to confirm that leakage of contaminants is not occurring from the tailings dam area or the containment cell, and to determine the quality of leachate collected by the leachate collection system. Semi-annual monitoring of surface water quality at the selected locations is recommended for the first five years following containment cell capping.

Provided that the results do not indicate any adverse impacts on surface water quality, the monitoring frequency would be reduced to an annual program following the initial five years.

6.3 Biomonitoring

Biomonitoring will be undertaken at the containment cell as well as within and along the new creekbank of Young's Creek. The biomonitoring program will be undertaken during the first growing season following containment cell construction and wetland reconstruction, and annually thereafter for a total of five years. Biomonitoring will then be conducted once every five years over a twenty year period, and then every ten years over the long-term period.

Visual inspections will also be conducted for the remedial work proposed along and within Young's Creek. These inspections will assist in ensuring that creekbank stability is not compromised and that the restoration measures implemented, including the installation of any bioengineering structures (i.e. root wads, fascines, wetland planting shelves and cells), are functioning as designed.

Qualified field personnel will evaluate the success of herbaceous vegetation (i.e. grasses, wildflowers, etc.) seeding and woody plantings on the containment cell cap and along the Young's Creek creekbank. Monitoring will also be conducted of the seeded and transplanted aquatic vegetation (i.e. cattails, sedges, and emergent/submergent species) within the creek. The inspections will ensure that all areas seeded and planted contain growing grass as well as other herbaceous and woody material. Plant health and condition will be monitored on and near these areas, and any planted terrestrial or aquatic vegetation that is determined to be inadequate or dead will be replaced. Native colonizing species of herbaceous terrestrial and aquatic vegetation, shrubs, and trees that germinate and grow in these areas will also be documented.

To further support the goals and objectives of this Closure Plan, the monitoring program may include the collection of plants (leaves and/or stems) from the remediated area during the growing season and prior to senescence. The concentration of arsenic and metals of concern in plant tissues could be chemically determined. Trends could be identified and comparisons to benchmark, toxicological and site data could be made to ensure that the goals of this Closure Plan are being met.

Evidence of terrestrial and riparian wildlife use, including direct sightings or signs such as tracks and scat, of the containment cell and the Young's Creek Area should be documented and recorded on a site map. Wildlife observations could be documented by qualified field personnel while undertaking the vegetation monitoring and thus, would be completed with the same frequency and over the same period of time.

Benthic invertebrate and fish community surveys may also be undertaken to document the re-colonization of the onsite and offsite portions of Young's Creek. These surveys would be completed by a fisheries biologist to determine the relative abundance, presence, distribution and diversity of benthic invertebrates and fish, and the activities taking place (i.e. spawning). Fish could also be collected from the onsite and offsite portions of Young's Creek and the concentration of metals in tissue determined. Trends could be identified and comparisons to

toxicological and site data could be conducted to ensure that the Closure Plan objectives are being met. These surveys would be conducted contemporaneously with the other monitoring work.

6.4 Site Management

It is anticipated that the proposed rehabilitation alternative will achieve the closure objectives for the Young's Creek Area (Section 1.3). The mitigation measures outlined in Section 7 will be taken to address any malfunctions and/or accidents that have a reasonable expectation of occurring.

7. Malfunctions, Accidents, and Mitigation Measures

During the implementation and operation of the rehabilitative measures at the site, there is a potential that malfunctions (i.e. in design, construction, or commissioning) or accidents (i.e. due to acts of nature) could occur. These malfunctions and accidents, although likely rare, could cause delays in implementation or problems in the operation and maintenance of the site, resulting in the need for costly mitigative measures. These events must be considered and mitigation measures must be developed to ensure environmental impacts are minimal and acceptable.

Table 7.1 identifies mitigation measures for potential malfunctions and accidents that have a reasonable probability of occurring at the site during three time frames:

- Short-term: Preparation activities
- Mid-term: Remediation activities
- Long-term: OMM activities

TABLE 7.1
MALFUNCTIONS, ACCIDENTS,AND MITIGATION MEASURES IN THE YOUNG'S CREEK AREA

Malfunction (M) or Accident (A)	Mitigation Measures
Short-term: Preparation Activities	
M/A – During construction of temporary works (temporary diversion dams and staging/waste conditioning areas), severe storm events may erode materials and transport contaminants via wind or stormwater	Contain stormwater, if possible, and ensure that sediment controls are in place, including sedimentation basins. Sequence work to avoid areas subject to erosion during severe storm events.
Mid-term: Remediation Activities	
M/A – Perpetual disruptive forces (MNDM, 1995)	The recommended alternative for the rehabilitation of the Young's Creek Area incorporates measures to mitigate perpetual disruptive forces.
M –Failure of tailings dam walls due to shallow blasting activities	Shallow blasting should not occur until the tailings dam walls are covered with the engineered cap described in the Tailings Area Closure Plan (CH2M HILL, 2004). A pre-blast survey should be conducted prior to blasting. Blast monitoring is required near the tailings dam walls during blasting activities.
A – Spill of contaminated soil, treatment plant related chemicals, fuel for construction equipment/vehicles	Construction contractors, treatment plant operators, and other site personnel should be trained to respond to spills. Spill would be isolated and transferred to waste consolidation area or to an acceptable waste receiver if spill occurs offsite.

TABLE 7.1
MALFUNCTIONS, ACCIDENTS,AND MITIGATION MEASURES IN THE YOUNG'S CREEK AREA

Malfunction (M) or Accident (A)	Mitigation Measures
M/A – During excavation and consolidation activities, severe storm events could expose contaminants or transport contaminants via wind or stormwater	Contain stormwater, if possible, and make sure that sediment controls are in place (see Section 4.7.3). Implement contingency plan to dewater ponded water in excavations. Sedimentation basins will be in place during construction activities. Sequence work to avoid areas subject to erosion during severe storm events. Excavation should be staged such that contaminated sediment cannot be washed into clean areas. These design measures should be sufficient during normal storm events.
M/A – During cap/construction soil and vegetation could erode	Straw blown onto sloped areas that are freshly planted, planting with annual rye or wheat will help stabilize the soil. If soil erodes, then replace the soil and replant.
A – Damage to existing leachate collection system during construction activities	Construction controls will be in place to limit vehicle weight over the liner system.
Long-term: Operation, Maintenance, and Monitoring Activities	
M/A – Perpetual disruptive forces (MNDM, 1995)	The conceptual design of the onsite containment cell incorporates measures to mitigate perpetual disruptive forces. Further refinements will be addressed during detailed design.
M – Breach of engineered cap	Although the thickness of the cap is designed to prevent penetration from tree roots and burrowing animals, there is a remote possibility that this can happen. Ongoing monitoring program will identify need for repairs to cap. The site OMM manual will provide cap repair procedures and protocols.
M – Vegetative cover stress due to soil conditions, contaminants, rodents, etc.	Install raptor perches to encourage hawks and owls to prey on rodents. Routinely monitor the integrity of the cap. Keep grass mowed to reduce potential for rodent damage. If vegetation mortality occurs, determine cause of mortality (i.e. soil conditions, contaminants, rodents) and rectify then replace vegetation.
M – Cap failure due to erosion, rodents, etc.	In the event of a cap failure, the liner would remain intact and any leachate generated in the waste would be contained by the base liner and collected by the leachate collection system. The leachate can be pumped out of the underground storage tank and transferred to a treatment system. Ongoing maintenance of the cap will ensure that failures are readily detected and repaired.
M – Liner Failure	Liner failure would be detected by surrounding monitoring wells and the release of leachate. If the cap remains intact, the volumes released would be extremely small.
M – Containment cell erosion due to flooding	Ongoing monitoring program will identify need for repairs to containment cell. The site OMM manual will provide containment cell repair procedures and protocols. Severe flooding may potentially compromise the integrity of the containment cell cap and could lead to the release of some of the contained sediment. The magnitude of the flood would need to be greater than the 100-year flood since the base of the cell will be above the floodplain. Mitigation measures would include damming of Young's Creek upstream of the site and channelling all water via the Moira River.

TABLE 7.1
MALFUNCTIONS, ACCIDENTS,AND MITIGATION MEASURES IN THE YOUNG'S CREEK AREA

Malfunction (M) or Accident (A)	Mitigation Measures
A – Seismic occurrences	Design long-term structures at the Deloro site to the appropriate Seismic Zone. The probability of an earthquake of sufficient magnitude to breach the cap of the waste is very small given the stability of the region (Zone 1, low risk of earthquake). Any damaged areas during such an event would be identified and rectified using defined maintenance procedures.

Notes: Perpetual disruptive forces are defined in MNDM (1995) to include wind erosion; water erosion due to flooding, sheeting, rilling, and gulleying; sedimentation and debris accumulation; annual ice accumulation; seasonal frost penetration; soil restructuring; and physical and chemical weathering. Biological activities include root penetration, burrowing, intrusion, and actions by animals and man.

8. Expected Post-Closure Conditions and Uses

This section provides an assessment and description of the expected conditions and uses following closure activities. In general, closure activities will result in a marked improvement to water quality, plant life, and animal life within the Young's Creek Basin. The effects of closure activities within the Young's Creek Area on land use, topography, water resources, and plant and animal life are discussed separately below.

8.1 Land Use

Access to the onsite portion of the Young's Creek Area will continue to be restricted to the public. A chain-link fence exists along the perimeter of the site and signage is posted to prevent public access and use. The onsite portion of Young's Creek will be different from existing conditions in that the water depth will be up to 1.5 m compared to existing depths of less than 0.5 m. In addition, following excavation of contaminated sediment and soil, most of the onsite portion of the creek basin will be under water year round. Currently, much of the onsite portion of the creek basin is dry with little to no water flow some of the year. A wetland environment would be established in the littoral zones surrounding the perimeter of the onsite portion of Young's Creek as a result of the construction of a perimeter wetland shelf. A wetland parcel would also be created at the southern extent of the onsite portion of the creek adjacent to Highway 7.

Land uses for the offsite portion of the Young's Creek Basin will be similar to current uses. The offsite portion of Young's Creek is privately owned although public access to this land is possible. Potential uses of the offsite portion of Young's Creek include recreational activities such as fishing and canoeing.

8.2 Topography

The topography of both the onsite and offsite portions of the Young's Creek Basin will be similar to existing pre-remediation conditions. The primary change in topography that will occur as a result of post-closure activities will be the secure onsite containment cell.

The containment cell will rise to an elevation of approximately 205 masl. The top of the containment cell will have an elevation similar to other localized topographic high points across the site. In the southern half of the site, where the containment cell is located, the localized topographic high points have an elevation of approximately 200 masl. In the northern half of the site, the localized topographic high points have an elevation of approximately 225 masl. Therefore the top elevation of the containment cell is generally consistent with the surrounding land.

Public visual impacts associated with the containment cell will be improved as the area is cleaned up and restored, and any negative impacts are anticipated to be very minimal.

Limited public visibility of the containment cell will exist at two locations, the Village of Deloro, and the Highway 7 bridge over Young's Creek. The top elevation of the containment cell (205 masl) will be similar to the ground elevation in the Village of Deloro. Considering the tree cover between the Village and the proposed containment cell, visual impacts to Deloro residents will be minimal. The elevated islands existing between the Highway 7 bridge and the proposed containment cell will act to block out much, if not all of the containment cell to traffic on Highway 7.

8.3 Water Resources

With regard to changes in the hydrology of the Young's Creek Basin, water depths in the onsite portion will increase up to 1.5 m depth. The increase in depth will occur as a result of the excavation of contaminated sediment/soil. The post-closure flow rate through the Young's Creek Basin will be similar to existing flow rates. The creek will continue to flow to the offsite portion through the bridge culvert beneath Highway 7. The three ponded areas in the offsite portion of the creek will remain post-closure, since the existing beaver dams and the one constructed concrete dam will be left in place. The depth of water in the three offsite ponded areas of Young's Creek will increase marginally by approximately 0.3 m. Surface water will continue to flow between the three ponds through relatively well-defined channels. Water will flow out of the Southern Pond through the bridge culvert under Old Marmora Road and discharge into the Moira River.

8.4 Plant and Animal Life

As outlined in Section 2.1.2 the risks to ecological receptors are not conclusive given the information that is currently available. It is expected that further SSRA work will find that post-closure conditions will result in acceptable risks to ecological receptors. Additional site information is being collected and further evaluation is underway (see Section 2.1.5). With respect to impact to fish, the SSRA concluded that no risk to fish populations is likely present pre-closure, and, will not be present following post-closure rehabilitation activities.

9. Approval Requirements

The primary site-wide regulatory approvals that must be applied for and issued by the appropriate government agencies are outlined in this section of the Closure Plan.

9.1 Site-Specific Risk Assessment

As previously noted, a Site-Specific Risk Assessment (SSRA) is the remedial approach that has been selected from the options available in the Guideline for Use at Contaminated Sites in Ontario (1997). There are a number of steps to approval of an SSRA to ensure that public health and the environment are protected. First, an SSRA is reviewed by an independent third party peer reviewer who is qualified and experienced in conducting SSRAs. Once the peer reviewer's comments have been incorporated, the SSRA is submitted to the Standards Development Branch (SDB) of the MOE, which undertakes a review of both technical and policy issues. Other prerequisites for acceptance of the SSRA include community-based public communication and dialogue with the municipality regarding the SSRA. Once these steps have been completed, the cleanup can proceed.

As confirmation that the actual cleanup is completed according to the SSRA, a Record of Site Condition (RSC) will be prepared and filed to document the cleanup. The RSC is completed jointly by the proponent, MOE, as well as the consultant overseeing the cleanup. The SSRA is a Level 2 Risk Management involving the use of engineered controls (i.e. engineered covers, groundwater pumping/treatment systems). A Level 2 Risk Management requires Registration on Title for the property to document the conditions of the land in the public domain. Registration on Title will be accomplished through filing a Certificate of Prohibition.

As a result of the different land ownership between the Deloro Mine Site and the Young's Creek Area south of Highway 7, a separate SSRA report will be submitted for each of these two land parcels following the process described in this section.

The current process for completing SSRAs, outlined above, was developed in 1997 and has been in place since that time. New legislation has been passed which is anticipated to modify this process once the enabling regulations are finalized. The new legislation, the *Brownfield Law Statutes Amendment Act*, received Royal Assent on November 21, 2001 and the public comment period for the regulations ended on April 29, 2003. Final regulations, which are expected to be released through 2003, may change the SSRA process from a guideline-driven to a regulatory-driven process. The draft regulations do not suggest significant change in the technical approach to SSRAs, but they do indicate some changes in the administrative aspects. The Deloro Mine Site SSRA will be adapted, if needed, to meet the new regulatory requirements.

9.2 MOE Authorizations

Under the *Environmental Protection Act* (EPA) and the *Ontario Water Resources Act (OWRA)*, approval is required from the MOE for processes which emit to the environment or for

waste management activities. The primary means of approval is through issuance of a C of A for air or water emissions or a Provisional Certificate of Approval (PC of A) for waste related activities. A Permit to Take Water (PTTW) is required for water extraction above 50,000 L/day. Generator Registration is required for ongoing waste generation, such as the ferric arsenate sludge which is generated by the onsite ATP.

A number of MOE authorizations already exist at the Deloro Mine Site as a result of environmental mitigation actions implemented to date. This includes extraction and pumping of impacted groundwater, treatment of water in the ATP, discharge of the treated effluent and storage/dewatering of sludge from the treatment process. A listing of the MOE authorizations currently in place at the Deloro Mine Site is provided in Table 9.1.

The Closure Plans will result in changes to the currently authorized systems, plus the addition of new systems. Changes to the current systems will require modifications to the existing MOE authorizations, most likely through an amendment (i.e. C of A Amendment). New systems will require new authorizations to be developed.

Certificate of Approval – Sewage

Amendment to the existing C of A for the ATP, sludge storage lagoon, pumping stations and forcemains may be required to accommodate modifications to these systems as a result of the Closure Plans.

Certificate of Approval – Air

There is no anticipated requirement for modification of the existing C of As or for new C of As as a result of the Closure Plans.

Permit to Take Water

The existing PTTW for the Tuttle Shaft pumping station will require amendment to account for installation of a permanent forcemain and the increase in pumping to a year-round operation. Other PTTWs for the other pumping stations may also require some modifications.

In the Industrial Area, a new PTTW will be required to authorize the construction and operation of a groundwater interceptor system. Similarly, a new PTTW will be needed in the Tailings Area for groundwater pumping from wells located in the vicinity of the tailings dam walls.

Provisional Certificate of Approval – Waste Disposal

The site cleanup is following the SSRA process (outlined above) where existing residuals and by-products will be managed onsite through a Level 2 Risk Management involving isolation and containment. Although the legacy materials being managed have been in place for many decades and are not the result of ongoing waste production, and many of the materials are the result of mining activities (i.e. mill tailings from a mine) that are exempt from Ontario's Waste Management Regulation, the MOE has committed to seeking a PC of A for the proposed waste management facilities under Part V of the EPA. The development of Closure Plans for the Deloro site has drawn on landfill design standards, as well as mine closure and other guidelines, as general guidance and best management practices to ensure that the site is engineered and maintained to be safe and secure for hundreds of years.

TABLE 9.1
EXISTING MOE AUTHORIZATIONS FOR THE DELORO MINE SITE

Authorization	Type	Number	Date	Description
Certificate of Approval	Sewage	4-036-82-006	28 Jul 1982	Collection/storage/treatment system
Certificate of Approval	Air	8-4042-82-006	8 Sep 1982	Lime silo venting and fume hood exhaust
Certificate of Approval	Sewage	4-053-83-006	18 Jul 1983	Pumping station and forcemain
Provisional Certificate of Approval	Waste Disposal Site	A362106	6 Sep 1983	Temporary storage processed sludge
Permit	PTTW	85-P-4006	26 Apr 1985	Tuttle shaft and pumping station #5
Certificate of Approval	Sewage	4-041-85-006	25 Jul 1985	Sludge drying lagoon
Permit	PTTW	85-P-4038	16 Aug 1985	Moira River
Certificate of Approval	Sewage	4-067-85-006	16 Sep 1985	Manhole rehabilitation
Certificate of Approval	Air	8-4069-86-006	17 Nov 1986	Plant exhaust system
Certificate of Approval	Sewage	4-116-86-876	8 Jul 1987	Tuttle shaft pump and forcemain
Certificate of Approval	Sewage	4-0155-87-006	20 Nov 1987	Sludge testing lagoon
Certificate of Approval	Air	8-4120-88-006	12 Dec 1988	Lab equipment exhaust
Generator Registration	Waste Streams	ONO199886	23 Jan 1989	Arsenic compounds and oils
Certificate of Approval	Air	8-4128-89-006	4 Dec 1989	Lab fume hood exhaust
Permit Amendment	PTTW	83-P-4010	6 Jun 1990	Pumping station #3
Permit Amendment	PTTW	82-P-4035	6 Jun 1990	Pumping stations #1, #2, and #4
Certificate of Approval Amendment	Industrial Sewage	4-041-85-006	27 Nov 1992	Sludge storage lagoon expansion
Permit Amendment	PTTW	85-P-4006	21 Feb 1996	Tuttle shaft and pumping station #5
Certificate of Approval Amendment	Industrial Sewage Works	4-036-82-006	20 Apr 2000	Decontamination facilities
Generator Re-registration (HWIN)	Waste Streams	ONO199886	Jan 2002	Ferric arsenate sludge
Provisional Certificate of Approval	Waste Disposal Site	2668-5DHJEW	30 Aug 2002	Temporary storage contaminated soil
Provisional Certificate of Approval Amendment	Waste Disposal Site	2668-5DHJEW	12 Nov 2002	Contingency plan

The Deloro Mine Site Cleanup Project is being carried out under an exemption to the provincial *Environmental Assessment Act* (EAA). Ontario Regulation 577/98 (O. Reg. 577/98) exempts the Deloro Mine Site Cleanup Project from a mandatory hearing under Part V of the EPA (Sections 30 and 32).

9.3 Conservation Authority

Through the Fill, Construction and Alteration to Waterways Regulation, which is administered in support of Section 28 of the Conservation Authorities Act of Ontario, the Conservation Authority regulates and may prohibit work taking place within valley, river, stream and watercourse corridors as well as along lake waterfronts.

Fill regulations allow the Authority to prohibit or regulate the placing, excavation, grading or dumping of fill of any kind for projects such as pools, ponds, roads and driveways. These regulations are applied when, in the opinion of the Authority, the control of flooding, pollution, or the conservation of land within its jurisdiction may be affected by the placing or dumping of fill.

Construction regulations allow the Conservation Authority to regulate construction in or on a wetland or floodplain, or in any area susceptible to flooding during a regional storm. In this regulation, construction refers to new buildings, additions to existing buildings, stormwater outfalls, culverts, and bridges.

The alteration to waterways regulation allows the Conservation Authority to prohibit or regulate the straightening, changing, diverting, or interfering with the existing channel of a river, creek, stream, or watercourse.

Based on the remedial works that are proposed along the west bank of the Moira River (reconstruction) as well as within Young's Creek (sediment and soil removal and wetland rehabilitation), it is anticipated that a permit "To Construct, Place Fill, or Alter a Waterway" will be required from the MRCA care of QC.

9.4 Ministry of Natural Resources

Of note within the Deloro Mine Site property and in the Young's Creek Offsite Area is a Provincially Significant Wetland (PSW), the Deloro Wetland Complex. The Deloro Wetland Complex, including the area along Young's Creek south of Highway 7, was evaluated during the summer of 2000 using the 3rd Edition of the wetland evaluation manual (Snider's Ecological Services, 2000). The wetland received a total score of 688 and was evaluated as a Class 2 PSW.

The management of Ontario wetlands and lands adjacent to them is implemented through the *Wetlands Policy Statement*, which falls under the jurisdiction of the *Planning Act*. The MNR and the Minister of Municipal Affairs jointly issued the *Wetlands Policy Statement*. The policy requires that all planning jurisdictions protect PSWs such that development is not permitted in PSWs that are located within the Great Lakes–St. Lawrence Region. Development and alteration may be permitted on lands adjacent to PSWs only if it does not result in:

- Loss of wetland function

- Subsequent demand for future development that will negatively impact existing wetland functions
- Conflict with existing site-specific management practices
- Loss of wetland area

An Environmental Impact Study (EIS) would have to be prepared in order to permit development on these adjacent lands.

Consultation is required with the MNR, and possibly the Minister of Municipal Affairs, to determine whether any of the project components, such as construction of the Young's Creek Area onsite containment cell and dredging, constitutes wetland "development" and whether the project can be permitted. Also, the MNR would need to determine whether an EIS would need to be completed.

The MNR is also responsible for issuing Work Permits under the authority and provisions of several different Provincial Acts. If the project is allowed to proceed, the Provincial Acts that apply to this project would have to be determined in consultation with the MNR. The following Provincial Acts and their regulations are considered in the application for a Work Permit.

Forest Fire Prevention Act: The MNR administers this Act. A Work Permit is required to authorize any work on Crown land and to ensure that adequate forest fire precautions and equipment are in place.

Lakes and Rivers Improvement Act: The purpose of this Act is to manage the use of the lakes and rivers in Ontario and to regulate improvements to them. The Act provides for the preservation of public rights in or over water; protection of the interests of riparian owners; management of fish, wildlife, and other natural resources dependent on such waters; preservation of natural amenities; and suitability of the location and nature of improvements. The *Lakes and Rivers Improvement Act* gives the MNR the mandate to manage water-related activities, particularly in the areas outside the jurisdiction of Conservation Authorities.

Public Lands Act: This Act, which is administered by the MNR, authorizes the construction of roads on Crown lands, sets out Crown cost-sharing of company roads, limitations on liability and tenure for private forest roads and camp areas, and defines the applicability of the *Highway Traffic Act* on access roads.

As part of the application for a Work Permit, each project proponent must complete and apply for "Parts" of the permit. The determination of which Parts (i.e. A through F) are applicable to the project is conducted in consultation with the MNR. The Parts that must be taken into consideration when applying for a Work Permit are briefly described below:

- *Part A*: Fire Prevention and Suppression/Logging Activities
- *Part B*: Mineral Exploration Activities
- *Part C*: Building Construction
- *Part D*: Application to do Work on Shore Lands
- *Part E*: Roads, Trails, or Water Crossings
- *Part F*: Works Within a Waterbody

Based on the work proposed at the Deloro Mine Site, a Work Permit will be required from the MNR. Several Parts to the application will have to be completed possibly including, but not limited to, Parts A, D, and F. It is anticipated that the MNR will include conditions pertaining to work in the PSW with those issued as part of the Work Permit.

9.5 Department of Fisheries and Oceans/ Canadian Coast Guard

9.5.1 Navigable Waters Protection Act

The purpose of the *Navigable Waters Protection Act* (NWPA) is to protect the public right to marine navigation and to ensure unobstructed passage of vessels in Canadian waters. Any construction, modification, or repair of a work that will interfere with navigable waterways must be approved or concurrence provided by the DFO, and is administered by the Canadian Coast Guard (CCG). The removal of obstructions to navigation and the provision and maintenance of lights and markers required for safe navigation is also covered under this Act. Although the section of the Moira River that passes through the site has limited use for boating, many parts of the Moira River are navigable and the CCG should be consulted on the final cleanup plan for the site.

9.5.2 Fisheries Act

The federal Minister of Fisheries and Oceans has the legislative responsibility for the administration and enforcement of the federal *Fisheries Act*. The *Fisheries Act* protects and conserves fish and fish habitats and has the power to deal with damage to fish habitat, destruction of fish, obstruction of fish passage, necessary flow requirements for fish, and the control of deleterious substances. Section 35(1) of the federal *Fisheries Act* states that "no person shall carry on any work or undertaking that results in the harmful alteration, disruption or destruction of fish habitat" (HADD). Any proposed works and activities that are likely to alter or damage fish habitat must be reviewed and authorized by the DFO. The Conservation Authorities have agreements with DFO in the evaluation and processing of applications and therefore would also have to be consulted.

It is important to note that DFO has also developed a Policy for the Management of Fish Habitat, which includes a No Net Loss guiding principle. This principle is applied to any proposed development that would result in a loss of productive fish habitat. The regulatory agency would review the measures to determine if they meet not only the No Net Loss principle, but also the DFO's long-term policy objective of achieving an overall net gain in the productive capacity of fish habitats. Therefore, works requiring an authorization from the DFO typically includes a Fisheries Compensation Plan, which describes the measures taken to realize an overall net gain in the productive capacity of fish habitats as a result of the project.

A section of the west bank of the Moira River in the Industrial Area will be reconstructed, and a significant amount of work is proposed within Young's Creek including the excavation of contaminated sediment/soil and wetland rehabilitation. As this will affect fish habitat, it is anticipated that a Fisheries Act authorization will be required and a Fisheries Compensation Plan may have to be prepared. In addition, an application for a blasting permit may be

required to address "destruction of fish by any other means" (under the *Fisheries Act*) since a portion of the onsite containment cell will be located in Young's Creek.

9.6 Environmental Assessment and CNSC Licensing

The *Nuclear Safety and Control Act* (NSCA) mandates the CNSC to regulate all aspects of the nuclear industry in Canada, including the management and isolation of nuclear wastes. Paragraph 26 of the NSCA states that:

> "Subject to the regulations, no person shall, except in accordance with a licence,...possess,...manage, store or dispose of a nuclear substance. . ."

It is with respect to this paragraph that the MOE seeks to obtain a licence to manage and store, at various locations on the Deloro Mine Site, the radioactive wastes present on the site. Conceptual waste isolation scenarios are presented in Section 3.4 of this and other Closure Plans for radioactive (and non-radioactive) materials.

CNSC's authorization of the project would be provided through the issuance of a Waste Nuclear Substance Licence (WNSL) for the possession, management, and storage of nuclear substances, pursuant to subsection 24(2) of the NSCA.

As previously noted, because nuclear waste management and storage is a physical activity listed in the "Inclusion List Regulation" of the CEAA, the proposed "project" is subject to the federal EA process. Therefore, the licensing and the Federal EA processes are closely linked, as explained below.

The screening level EA process being followed for this project is summarized in Section 2.2. At the completion of the EA study, the proponent must summarize the process and the results of the EA into a report that is submitted to the RA for its review. Once the RA is satisfied that the EA has met the initial scope, the report is then submitted to the members of the CNSC for its approval. A hearing in which the proponent presents the project and where the public is invited to voice its concerns or support may be required.

Following the approval of the results of the EA by the CNSC, an application for a WNSL must be formally submitted by the proponent in accordance with the General Nuclear Safety and Control Regulations and Nuclear Substance and Radiation Devices Regulations of the NSCA. A WNSL is applicable, as opposed to a Class Ib Nuclear Facility Licence, because mainly chemical wastes are being managed with the presence of some radioactive materials.

As part of the application for a WNSL, safety analyses must be conducted to ensure radiation exposures to both workers and the public are acceptable during normal and abnormal conditions at the site.

Some applicable portions of the General Nuclear Safety and Control Regulations which must be addressed in the application are as follows:

> 3 (1) (*e*) the proposed measures to ensure compliance with the *Radiation Protection Regulations* and the *Nuclear Security Regulations*;
> (*f*) any proposed action level for the purpose of section 6 of the

Radiation Protection Regulations;
(*g*) the proposed measures to control access to the site of the activity to be licensed and the nuclear substance, prescribed equipment or prescribed information;
(*h*) the proposed measures to prevent loss or illegal use, possession or removal of the nuclear substance, prescribed equipment or prescribed information;
(*i*) a description and the results of any test, analysis or calculation performed to substantiate the information included in the application;
(*j*) the name, quantity, form, origin and volume of any radioactive waste or hazardous waste that may result from the activity to be licensed, including waste that may be stored, managed, processed or disposed of at the site of the activity to be licensed, and the proposed method for managing and disposing of that waste;

Some applicable sections of the Nuclear Substance and Radiation Devices Regulations are as follows:

3. (1) An application for a licence in respect of a nuclear substance or a radiation device, other than a licence to service a radiation device, shall contain the following information in addition to the information required by section 3 of the *General Nuclear Safety and Control Regulations*:
(*a*) the methods, procedures and equipment that will be used to carry on the activity to be licensed;
(*b*) the methods, procedures and equipment that will be used while carrying on the activity to be licensed, or during and following an accident, to
(i) monitor the release of any radioactive nuclear substance from the site of the activity to be licensed,
(ii) detect the presence of and record the radiation dose rate and quantity in becquerels of radioactive nuclear substances at the site of the activity to be licensed,
(iii) limit the spread of radioactive contamination within and from the site of the activity to be licensed, and
(iv) decontaminate any person, site or equipment contaminated as a result of the activity to be licensed;
(*c*) a description of the circumstances in which the decontamination referred to in subparagraph (*b*)(iv) will be carried out;

Following submission of the application and any clarifications and/or additional materials required by CNSC staff, a draft licence is then prepared by CNSC staff, discussed with the proponent and ultimately presented to the members of the CNSC for approval. A hearing in which the proponent presents its application and where the public is invited to voice its concerns or support may be required. Upon acceptance, a WNSL is issued and remedial work can begin under the conditions of the Licence.

9.7 Mining Act

The regulatory considerations relevant to the Deloro project were examined early in the project and have been refined as the project has progressed. The document entitled *Deloro Mine Rehabilitation Project – Development of Closure Criteria, Final Report* (CG&S, October 1998) summarized the application of the *Mining Act* to the Deloro project. Even though the Crown

(i.e. the Provincial Government) is exempt from the requirements of the *Mining Act*, the Closure Plans have been developed to satisfy general requirements of the document entitled *Rehabilitation of Mines, Guidelines for Proponents* (MNDM, 1995). MNDM has agreed tc review the Closure Plans relative to accepted standards for closure and rehabilitation of mines in Ontario, although a specific approval will not be issued.

10. References

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APPENDIX A

SUMMARY OF MAJOR COST ITEMS FOR YOUNG'S CREEK AREA CLOSURE PLAN

APPENDIX A

Summary of Major Cost Items for Young's Creek Area Closure Plan

Opinions of Probable Construction Cost

In providing opinions of probable cost, MOE understands that CH2M HILL has no control over the cost or availability of labour, equipment or materials, or over market conditions or the potential Contractor's method of pricing. CH2M HILL makes no warranty, express or implied, that the bids or the negotiated cost of the Work will not vary from the opinion of probable construction cost.

CH2M HILL has made efforts to acquire area specific rates for materials, labour, and equipment whenever possible. The suitability of said materials to the intended purposes were not verified and will need to be determined prior to any construction activities. Where a local source or supplier could not be identified, industry budgetary tools such as the R.S. Means Company Inc. costing guide were used to assign a typical value. Appropriate regional coefficients were applied where necessary to adjust the typical costs to address regional conditions.

Each specific area of interest has been examined as an independent project. Any possible synergies associated with co-execution of various areas were ignored. Prices provided include the federal Goods and Services Tax (GST).

Volumes and areas were determined using existing available information. No additional investigations were performed to confirm or refute the estimates. Some estimates such as potential water volumes were based on engineering experience from other similar projects. Probable construction costs were based on typical weather conditions and may require adjustments due to extreme conditions.

Certain construction costs such as overhead, insurance, and various construction bonds will vary based on the potential Contractor. Financial strength, experience, and previous history all play a role in determining the rates that will be applied to a particular Contractor. These sums were determined as a percentage of the total costs based on industry averages.

Several of the site remediation options involved additional pumping to the arsenic treatment plant located in the Industrial Area. The application of a varied number of options over the four main areas will result in increases and decreases of the total treated water volume. At this conceptual stage it is difficult to determine whether there will be a net increase or decrease to the volume of water to be treated. Therefore, the operation and maintenance of the arsenic treatment plant has only been considered in the Industrial Area Closure Plan. Actual operation and maintenance costs over the last decade were used to develop a weighted-average and one standard deviation was added to this value in an effort to create a conservative estimate. Wastewater treatment considerations for all other areas

were limited to collection and transmission to the equalization pond (i.e. equalization/storage basin).

Finally, a 15 percent contingency was added to the final capital cost (before taxes, overhead, insurance, and bonds) and a 5 percent contingency was added to the final OMM costs (before taxes).

The net present value costs presented in the following cost breakdown are the sum of the capital cost and the net present value of the OMM costs. The annual OMM costs have been transformed to a net present value assuming an effective interest rate of 5 percent and a planning horizon of 20 years. The effective interest rate includes inflationary effects. It should be noted that OMM effort and costs will be required beyond the 20-year horizon. The 20-year period was selected based on the assumption that it is a reasonable period for budgetary planning purposes.

Cost opinions were developed based on information available at the time this report was prepared and are expected to have an accuracy on the order of +/- 25 percent. Use of this information for project budgeting purposes should include a factor for escalation if the contract will not proceed in the same calendar year.

Appendix A

Breakdown of Capital Costs of Work Packages and Operation, Maintenance, and Monitoring Costs

Young's Creek Area Remediation Costs

Work Package Identification Number and Description			Estimated Cost*	Total
YC-WP#1	**Containment Cell Liner System**			
	Access Routes		$40,000	
	Set-up		$90,000	
	Water Diversion Channel		$270,000	
	Water Control Structure		$300,000	
	Preparation of Storage Cell Site		$4,030,000	
	Liner		$2,290,000	
	Personal Protective Equipment		$15,000	
Total				**$7,035,000**
YC-WP#2	**Onsite Contaminated Sediment and Soil Excavation, Dewatering, and Placement in Containment Cell (includes cap construction)**			
		Decon Pad (Onsite)	$20,000	
		Staging Areas	$775,000	
		Sedimentation Basin	$10,000	
		Excavation	$1,815,000	
		Verification Sampling Program	$22,000	
		Water Management	$140,000	
		Storm Events (material on standby)	$100,000	
	Cap			
		Cap Construction	$2,660,000	
		Vegetation	$50,000	
		Personal Protective Equipment	$8,000	
Total				**$5,600,000**
YC-WP#3	**Onsite Creek Rehabilitation**			
	Three-metre Shelf Around Perimeter		$75,000	
	Wetland Planting Cells (10 m x 10 m)		$125,000	
	Wetland at Southern Boundary of Highway 7		$150,000	
Total				**$350,000**
YC-WP#4	**Offsite Contaminated Sediment Excavation, Dewatering, and Placement of Containment Cell (includes cap construction)**			
		Set-up (Offsite)	$265,000	
		Water Diversion (structure at Highway 7)	$445,000	
		Road Construction	$430,000	
		Turn Around Areas	$30,000	
		Decon Pad	$50,000	
		Staging Areas	$625,000	
		Sedimentation basin	$15,000	
		Excavation	$600,000	
		Verification Sampling Program	$20,000	
		Water Management	$140,000	
		Storm Events (material on standby)	$100,000	
	Cap			
		Cap Construction	$800,000	
		Vegetation	$15,000	
		Personal Protective Equipment	$3,000	
Total				**$3,538,000**
YC-WP#5	**Offsite Creek Rehabilitation**			
	Three-metre Shelf Around Perimeter		$75,000	
	Wetland Planting Cells		$125,000	
	Wetland at Discharge Point into Moira River		$150,000	
Total				**$350,000**
Operation, Maintenance, and Monitoring Cost Items (Average Weighted Annual Costs)				
Total Average Annual OMM Costs**				**$41,508**
Net Present Value of OMM Costs				**$665,000** ***
Net Present Value of Capital and OMM Costs				**$17,538,000**

All capital costs include GST and a 15 percent contingency (before taxes, overhead, insurance, and bonds).
All OMM costs include GST and a 5 percent contingency (before taxes).
*All costs have been developed using 2004 pricing and do not include an escalation factor.
**Includes removal of leachate from holding tank, monitoring program, and maintenance of containment cell and wetlands.
***Net present value of average weighted OMM costs using an effective interest rate of 5% per year and a planning horizon of 20 years.